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THE NEW BOX CARS OF 60,000 LBS. CAPACITY of the Norfolk & Western R. R. are good examples of modern design. There are two side sills, 5 × 8 ins., two center sills, 4½ × 8 ins., and four intermediate sills, 4 × 8 ins. The four 1⅛-in. truss rods pass through the end sills, which are 8 × 8 ins. at the middle. The oak draft timbers are under the side sills and extend back to the I-beam body bolsters, while subsills extend from the bolsters to the needle beams. In the body framing there are two 4-in. I-beam posts at each end, fitting into cast-iron pockets. Iron deadblocks are placed on each side of the couplers. The body bolster is of two 6-in. I-beams, and the truck bolster of two 9-in. I-beams. A nest of six helical springs is placed under each end of the truck bolster, seated on a channel iron spring plank. The axles have collarless journals, 4¼ × 8 ins. The truck frame is of the diamond pattern, with upper arch bar, 1¼ × 4 ins.; lower arch bar, 1 × 4 ins., and tie-bar, ½ × 4 ins. The cars were designed by Mr. R. H. Soule, Superintendent of Motive Power, and 500 have been built by the Ensign Mfg. Co., of Huntington, W. Va., and 100 by the Lenoir Car Co., of Lenoir, Tenn. The general particulars are as follows:

Length over end sills	36	ft. 1	in.
" inside body lining	33	" 8¼	ins.
Width over side sills	8	" 9	"
" over eaves	9	" 6½	"
" inside lining	8	" 9	"
Height, top of sill to bottom of roof plate	6	" 9	"
" rail to top of sill	4	" 1	"
Wheels, diameter	2	" 9	"
Wheelbase, truck	5	" 0	"
" total	33	" 4	"
Distance c. to c. of trucks	28	" 4	"

THE RAILWAYS OF SOUTH AUSTRALIA for the year ending June 30, 1895, according to the report of the Railway Commissioner, showed a decrease in gross earnings and passenger traffic, due to the depressed state of trade, but it is noted also that there has been a steady decrease in the number of passengers since 1892, which is certainly a very strange showing. Heavier axles are being fitted to passenger and freight cars on account of the number of accidents due to broken axles. The report of Mr. A. B. Moncrieff, M. Am. Soc. C. E., Engineer in Chief, states that every expenditure on maintenance which could possibly be postponed without danger to traffic has been held over, but that this will eventually result in increased cost, and that if the lines are to be kept open it will be imperative to relay long lengths at no distant date. The general results of operation for the year are as follows:

Length of line open, 3 ft. 6 ins. gage, miles	1,229¼
" " " 5 " 3 " " "	492¾
" " " total "	1,722
Capital cost per mile	$36,355
Gross earnings	$4,800,775
Operating expenses	2,844,865
Net earnings	1,955,910
Percentage of operating expenses to gross earnings	59.26%
Freight carried, tons	1,000,408
Train mileage	3,393,916
Average haul per passenger, miles	12.48
" " per ton, "	122.29
Average receipts per passenger per mile, cts.	1.48
" " " ton " " "	2.62
Number of locomotives	305
" " cars in passenger service	353
" " cars in freight service	6,130
Miles of line per 1,000 population	4.95
Population per mile of line	202

THE COST OF TIES IN TEXAS, as taken from the returns of tie renewals in the report of the Railroad Commission of Texas, for the year ending June 30, 1895, is given in the following table. It will be noted that the price of burnetised ties is a very fair average price for good ties of untreated timber, and their greater life should make them very economical in service. Some notes on this point were given in our issue of March 7, 1895:

	Range.	Average.
Burnetised	28 to 34	31
Burnetised pine	34.62	34.62
Cedar	32½ to 50	41.37
Culls	14.7 to 15	14.85
Cypress	28.1, 44 and 50	39
Mesquite	30	30
Oak	20 to 41½	30.75
" hewed	15	15
" sawed	22	22
" white and post	40.17	40.17
" second class	15	15
Pine	12½ to 45	28.75
" sawed	26	26
" long leaf	28.8	28.8
" yellow	40 to 50	45
" burnetised	34.62	34.62
" treated	46	46
Bridge ties, creosoted	$1.09 to $1.12	$1.10
Switch ties	60 to 80	70
" cypress	80	80

THE MOST SERIOUS RAILWAY ACCIDENT OF THE week was a crossing collision on the Pennsylvania R. R. near Harrisburg Pa., March 17. An extra freight train was crossing from one track to another to get round a blockade of trains, when a misplaced switch sent it on to the eastbound passenger track, just as an express train was approaching, the passenger engine striking the freight engine a glancing blow from the rear. The engineman and fireman of the passenger train were killed, and 7 persons were seriously injured, while 12 others were more or less cut and bruised. It is thought that the switch must have been left open by trackmen who had been clearing the snow away.—A collision between a snow plough and a local freight train occurred March 12 near Kent, Conn., on the Berkshire Division of the New York, New Haven & Hartford R. R.

THE COLLAPSE OF A TRESTLE over Broad River, near Columbia, S. C., on the Spartanburg, Union & Columbia branch of the Southern Ry., occurred March 4. A derailed car in a freight train of 21 cars was the cause of the accident, and 11 cars went down with the wreck. One man was killed.

THE SLIDING OF AN EMBANKMENT of the New York, New Haven & Hartford R. R., near Hartford, Conn., March 17, caused some interruption to traffic. About 125 ft. of the bank settled down and then slid out.

THE EXPLOSION OF A LOCOMOTIVE BOILER occurred on the Delaware, Susquehanna & Schuylkill R. R., March 11, while the engine (which was attached to a coal train) was standing on the track between Gum Run and Deringer, Pa. The flagman who had gone back was the only man who escaped, four men in the cab being killed and another, who had just stepped out of the cab, being seriously injured.

BOILER EXPLOSIONS and explosions of gas, powder, etc., are happening this month with the usual frequency. A technical journal stated recently that there was a boiler explosion in the United States every week. Five or six a week would be nearer the correct figure, and adding gas, steam-pipe and powder explosions would bring the total up to an average of one per day at least. This includes only explosions that are reported in the newspapers. There are doubtless many minor ones which are never reported save in local journals.

THE EXPLOSIONS reported during the past week include explosions of a boiler at Laurel Hill Mine No. 1, near Pittsburg, on March 11, killing two boys and wrecking a boiler house; of a saw-mill boiler at Halls, near Bradford, Pa., demolishing the mill and injuring two employes; of a boiler in the Troy Laundry Machinery Co., in Chicago, killing one man and scalding nine others who were digging foundations for a new boiler. A still exploded in a distillery at McKeesport, Pa., killing one man and damaging property to the extent of $10,000. An explosion of natural gas leaking from a furnace at Spang Chalfous & Co.'s mill in Pittsburg, burned two laborers, and another natural gas explosion took place in Cincinatti, where the gas was struck on boring an artesian well 300 ft. deep, rushed up to the boiler room and there exploded, wrecking the boiler house.

AN EXPLOSION OF GIANT POWDER took place in the Centre Star mine, at Rossland, B. C., on March 14, killing four men and fatally injuring two others. The men were thawing two boxes of the powder in a hot-water tank.

THE ELECTRIC CONDUIT RAILWAY OF THE Metropolitan Traction Co., on Lenox Ave., New York city, is said to have emerged successfully from the tests to which the recent severe snow storms have subjected it. The storm of March 16 caused little interruption to traffic, the track being kept clear by sweeping machines, and no trouble being experienced with the electric conductors in the conduit. During the snow storm of March 11 the operation of the road was hardly interfered with. The snow began to fall about 8 a. m., and the snow sweeper was started out over the line, but before it could make the complete trip the sprocket wheels of the broom broke and it was necessary to push the sweeper back into the barn for repairs, where it remained until 4 p. m. Meanwhile the cars ran over the unswept tracks with no greater delay than would be ordinarily caused by considerable slipping of the car wheels on the snow-covered rails; the trips being about eight or ten minutes longer than usual. At some points the snow was drifted over the tracks by the wind, making it necessary for the motorman to back his car to get the necessary momentum to force the car through. After 4 p. m. the snow sweeper cleared the line and schedule time was resumed. About 8 p. m. the storm turned to sleet and hail which covered the rails with ice, but the cars were able to make their usual headway. On the Lexington Ave. electric conduit line a gang of men swept the tracks and the cars made schedule time while the bad weather prevailed. Throughout the storm no electrical trouble of any kind was developed either in the conduit or in the cars. Both these lines have the conduit system of the General Electric Co.

BIDS FOR THE DISPOSAL OF THE GARBAGE of New York city are now asked for the third time within a few months, the date for opening the bids being March 26, and the contract being for five years. Under the first call the bids were to be for a lump sum per year, and no formal bids were received. Next the bids were to be on the basis of price per ton, on an estimate of an average of 800 tons per day, and five bids were received. Now the lump sum basis is again adopted, and the estimated daily average is 600 tons, but a plant with a daily capacity of 900 tons must be provided. The garbage will be delivered to contractors at the 18 dumps of the city, and must be removed from the city and disposed of in an unobjectionable manner. Bids for the disposal of ashes and other refuse are also wanted, these bids to be opened March 30. Col. Geo. E. Waring, Jr., M. Inst. C. E., is Commissioner of Street Cleaning.

THE CANALIZATION OF THE RIVER AVON, in England, for the seven miles between the city of Bristol and the Bristol Channel, has been reported upon by Mr. J. Wolfe Barry, M. Inst. C. E. The river is narrow and winding, and is navigable only at high tide, while the tidal range from low to high water is 14 ft. as a minimum and 46 ft. as a maximum. In view of the difficulties of navigation, private docks were established at Avonmouth and Portishead, on opposite sides of the mouth of the river, and these were eventually acquired by the city. The bulk of the traffic, however, still goes up to the city docks, unless the ships are too large to be safely navigated, and some means of improving the navigation have long been desired. The report states that there are no great engineering difficulties as far as construction is concerned, but that the questions of the disposal of the city's sewage and of preventing floods in the valleys of the Avon and Froom above the city in time of storms will require very careful consideration. The general project is for a dam, with an entrance lock, a dry dock which could be used as an entrance lock in emergency, and sluices operated by hydraulic power for lowering the level of the water in the river in time of heavy rain in the upper valleys. The cost of the dam, locks and sluices, is estimated at $7,450,000, and the total cost at $12,900,000. Besides this there would be required about $1,000,000 for straightening the river channel, widening and deepening it to give 26 ft. of water at high tide on a bottom width of 60 to 80 ft., and easing the curves to 1,800 ft. radius, there being now some curves of 700 ft. radius. The lighting of the channel by gas buoys and beacons, as on the Clyde, at Glasgow, is also recommended.

WATER PURIFICATION AT ELMIRA, N. Y., or a new source of supply, is demanded by the local board of health, and a committee of the city council seems to be working towards the same end. From Jan. 3 to March 10, there were reported in Elmira 275 cases of typhoid fever. A sample of water from the Chemung River at the water-works intake, taken last December, showed 46,476 bacteria per cu. cm., and a later examination has shown 18,314. The health board passed a resolution on March 10 giving the Elmira Water-Works Co. ten days to take action towards purifying the present supply or obtaining water from a new source.

COMPRESSED AIR LOCOMOTIVES; NEW ORLEANS & WESTERN R. R.

The use of locomotives operated by compressed air offers special advantages for handling large quantities of cotton, as at wharves, warehouses, etc., where the danger from the sparks and cinders of a steam locomotive and the sparking of electric motors, renders either of the latter methods of traction inadvisable. In our issue of Nov. 21, 1895, we illustrated and described the warehouse and terminal system of the New Orleans & Western R. R., at Port Chalmette, near New Orleans, La., where all the hauling and shifting is done by compressed air locomotives, and we illustrate this week one of the engines used, Figs. 1 and 2. We also show the engine hauling a train load of 80 tons of cotton up a grade of 3%, this latter view, Fig 3, being taken from a photograph furnished us by Mr. A. J. Swanitz, Chief Engineer and General Manager of the railway company.

Two of these locomotives have been built by H. K. Porter & Co., of Pittsburg, Pa., and are small four-wheel switching engines running on tracks of 36 ins. gage. Each engine has two cylindrical air tanks, one 15 ft. 2 ins. long, and one 17 ft. 2 ins. long. Both tanks are 31⅝ ins. inside diameter, built up of 9-16-in. shell plates, the longitudinal seams sextuple riveted, with inside and outside welt strips, and the circumferential seams double riveted. The tank heads are of 13-16-in. flanged steel, of dished shape, with manholes in the front heads. The working pressure in the tanks is 600 lbs. per sq. in., and this is reduced to 140 lbs. in the auxiliary reservoir by means of an automatic pressure regulator. The Stephenson link valve motion is used, operating a plain D slide valve, and graduated to cut off equally at all points of the stroke. The general dimensions of these engines are as follows:

Gage	3 ft. 0 ins.
Wheels, diameter	2 ft. 2 ins.
Journals	4¼x5½ ins.
Wheelbase	5 ft. 3 ins.
Weight in working order	24,500 lbs.
Cylinders	9x14 ins.
" center to center	4 ft. 5¼ ins.
" center to valve face	9½ ins.
Piston rod, diameter	1½ ins.
Guides	Single bar
Connecting rod, length c. to c	5 ft. 10⅛ ins.
Inlet ports	¾x7⅝ ins.
Exhaust ports	1¼x7⅝ ins.
Slide valves, outside lap	5-16 in.
" max travel	2⅛ ins.
" lead	1-16 in.
Capacity of air tanks, total	163 cu. ft.
Pressure in tanks	600 lbs.
" in auxiliary reservoir	140 lbs.
Brakes	Hand lever brake
Tractive force per lb. effective press. on piston	43.61 lbs.
Total tractive force with effect. press. equal to 4-5 of press. in aux. reservoir	5,000 lbs.
Total adhesive tractive power at 1-5 of weight on driving wheels	4,900 lbs.

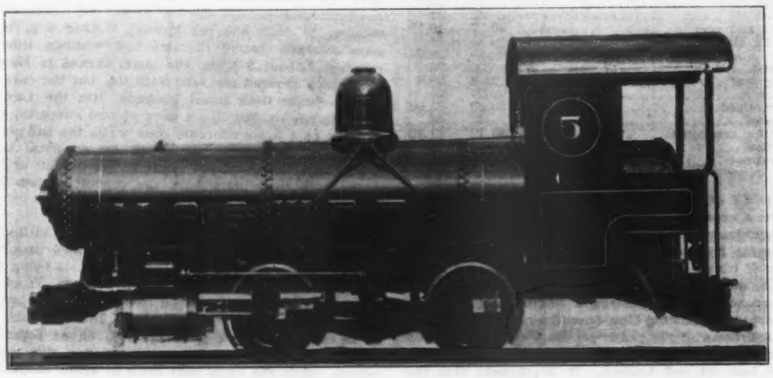


FIG. 1.—COMPRESSED AIR LOCOMOTIVE FOR NEW ORLEANS & WESTERN R. R.
H. K. Porter & Co., Builders.

FIG. 3.—COMPRESSED AIR LOCOMOTIVE HAULING A TRAIN LOAD OF 80 TONS OF COTTON UP A 3% GRADE.

THE CORONER'S VERDICT IN THE BEDFORD BRIDGE ACCIDENT.

The following verdict has been announced by the coroner at Cleveland, O., upon the fall of the bridge over Tinker's Creek on the Akron, Bedford & Cleveland Ry. on Jan. 9, 1896, which caused the death of the conductor of the car which was crossing the bridge when the accident occurred:

It is a deplorable fact that in this state bridges such as this one are not subjected to a rigid inspection during construction by some competent agent of the people, who should be held under a heavy bond for the faithful performance of his duties, thus giving the traveling public some assurance that such bridges are properly constructed, built of proper material, and are safe. It does not seem reasonable that railroad companies when required to place gates at a crossing, should be required to first submit their plans for the same to inspection by a public official, and be allowed to contract for and build high bridges without any restriction whatever or without the traveling public being protected in any manner from defects in workmanship and material. I do not wish to be understood to believe that any railroad or other corporation would knowingly construct a bad bridge, as it would eventually work to their detriment, but there should be some person who stands in a disinterested position to see to it that these bridges built for public use are stanch and safe, and that these "lowest bidders" fulfill their contracts.

When such accidents as the one we have just finished investigating happen, the public in nearly all cases expect that some one will be held criminally responsible, and yet it is in a majority of these cases a very difficult thing to do. In this case the testimony is somewhat conflicting, yet I find one point in the case which cannot be excused or overlooked. Competent and experienced men who are considered experts in this line of business, tell us that in the plans of this structure the main ties were designed and put into this structure about one-half the size and strength they should have been, which seems to be a fearful want of skill on the part of the person who drew the plans, as the whole structure was thereby reduced in strength to the same extent. Competent and experienced men testify that the tests made by them of the material used in this bridge show that the same was too high in phosphorus, and was not uniform in quality, the latter being a most serious defect, indeed. They also testify that the workmanship was very bad in many respects, and principally in gouging or double punching the main tie at the point where the structure evidently

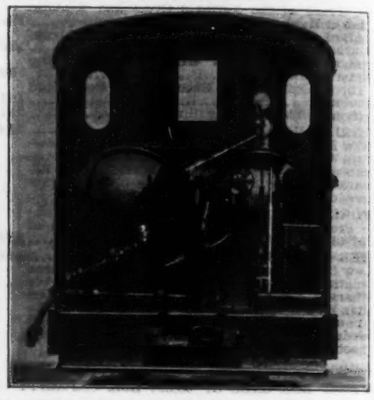


Fig. 2.—Rear View of Compressed Air Locomotive.

gave way, but that the structure was weakened thereby enough to have caused the accident. From the statements of the workmen and the superintendent himself, it is evident that the latter was grossly careless in his supervision of the construction of this bridge. The American and English Encyclopaedia of Law defines criminal negligence as follows: "Whoever does an unlawful thing carelessly, or a lawful thing in an unlawful manner, or through wanton or reckless or willful misconduct or neglect or gross want of skill and attention, or through willful omission or neglect of duty, endangers the life of another, is guilty of a crime."

There is no doubt from the evidence before us that this accident was the natural and consequent result of a gross want of skill or reckless misconduct and inattention, and I cannot see my way clear to do otherwise than hold the person guilty of such misconduct responsible. I desire also to say that if the evidence would warrant I should most certainly hold the superintendent of this bridge responsible for the careless manner in which he discharged such important duties. I therefore find that Lyman Haymaker came to his death on the 9th day of January, 1896, at or near the Akron, Bedford & Cleveland Ry. bridge, over what is commonly called Tinker's Creek, near Bedford, O., from injuries sustained on account of said bridge breaking down while the said decedent and other employees of said railroad company were crossing said bridge, causing decedent to fall a distance of about 60 ft., from which he sustained mortal injuries, and died soon thereafter. I further find that said accident was due to, and said injuries resulted from the failure of one J. M. Braly to use reasonable skill and due caution and care in planning or superintending the planning of said structure, and that said accident was the natural and consequent result of the misconduct aforesaid.

TESTS OF STRENGTH OF VITRIFIED CLAY.

We have received from Mr. Frank P. Johnson, late City Engineer of Waltham, Mass., some particulars of recent tests made of the strength of vitrified clay briquettes and bars, and these tests are of interest in connection with the use of this material in floors, roofs, arches, bridges, etc. The description of the tests is given in Mr. Johnson's own words as follows:

The cross breaking strength of vitrified clay in the shape of flat tiles became of importance in a structure I was designing, and after some little search, being unable to discover any applicable data upon the subject in current engineering literature, the books of the Boston

Public Library, or information in possession of brother engineers whom I could meet, I decided to make a few tests, the results of which are shown in the accompanying table. We wanted to use 600 as a co-efficient of strength (C) of this material to replace "M" in the expression $M = \frac{3FS}{2BH^2}$ for load applied at center of span between supports, this value of C giving us a safety factor of about 7 in the structure. In the formula, F = force in pounds applied necessary to break; S = clear span, in inches; B = breadth; and H = depth of specimen tested, both in decimals of inches.

The Portland Stoneware Co., of Portland, Me., made for us some 25 briquettes of the standard Am. Soc. C. E. cement briquette shape, and as many more bars about 1-in. square section and 9 ins. long, of their clay as used in the manufacture of sewer pipe.

All the specimens but one burned to smaller sections than 1 sq. in. and all distorted somewhat, but I thought not so as to materially affect the result with the 9-in. bars. The briquettes, however, could not be made to seat smoothly (even after being ground with an emery wheel) in any clips of the cement testing machine, and I therefore consider the tensile tests as falling an unknown, though considerable, amount below the record of the real strength of the material.

For the bars we had constructed a device to fit our Fairbanks 2,000-lb. cement testing machine, adjusted in such manner that they could be broken with a center load at any span from 4 to 8 ins. The bearings on which the bars were broken were of hardened steel, carefully ground and rounded, and presenting edges at contact points of about the thickness of No. 4 needle wire. These vitrified earthenware bars were broken at the 8-in. span and the pieces again at 4-in. span so that with 23 specimens we secured 66 breaks, 63 of which gave by the formula mentioned an average computed C of almost precisely 2,500, there being but one below 2,000 and one above 3,000. The first three breaks would have increased C had they been used, but these were omitted because of a failure to note which dimension was H and which was B when the bars were broken and calipered.

From the complete list of results of the tests we have selected twelve of the bars and twelve of the briquettes, showing the general range of the results. The bars showed an average height (H) of .9369 in., an average breadth (B) of .9273 in. and an average section of .8688 sq. in.

Tests of Strength of Vitrified Clay.

Briquettes.				Bars.				
Section at break.		Broke at. Lbs. Per	Span. ins.	Section at break. Ins.		Broke at. Lbs.		
Ins.	Sq. Ins.	Lbs. Sq. In.	S.	H. B.	Sq. Ins.	F.	M.	
1 × .86	.8600	663	771	8	.90 × .1	.9000	130	1,926
1 × .86	.8600	761	885	8	.94 × .97	.9118	146	2,044
.98 × .98	.9623	800	928	8	.91 × .89	.8099	134	2,182
.98 × .85	.8529	791	950	8	1 × 90	.9000	193	2,573
.94 × .94	.8836	872	987	8	1 × .92	.9200	201	2,621
.97 × .88	.8536	873	1,023	8	.98 × .91	.8918	198	2,722
.97 × .90	.8729	920	1,054	4	.94 × 1.05	.9870	324	2,095
.92 × .92	.8464	918	1,085	4	1.02 × .95	.9486	350	2,347
.95 × .91	.8642	959	1,110	4	.95 × .95	.9025	361	2,527
.98 × .85	.8330	968	1,162	4	.98 × .91	.8918	414	2,843
1 × .85	.8500	1,031	1,213	4	.97 × .91	.8826	423	2,964
.92 × .92	.8464	1,050	1,240	4	.97 × .91	.8826	440	3,083

Mr. Johnson states that he will be pleased to make and report upon similar breaking tests of other clays if manufacturers will forward samples.

A NEW FORMULA FOR THE CURVATURE OF CHORDS IN TRUSS BRIDGES.

By Benj. F. La Rue.

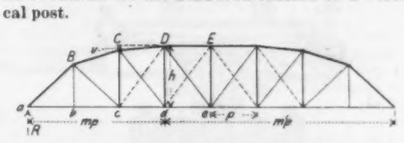
The use of curved chords for truss bridges of considerable span has become a common if not an almost universal practice, although its development is comparatively recent. While it has been objected to by a few conservative designers, the present practice indicates that the curvature or varying inclination of chords has become a permanent feature of bridge design. In long span truss bridges, curved chords afford a high degree of economy. The writer is unable to discern any valid objection to them of sufficient importance to outweigh their advantages.

The well-known Schwedler formula, which indicates the maximum amount of curvature which may be given to the chord without requiring additional counters, has undoubtedly exerted a very considerable influence in the development of this feature of bridge designing. In many, if not in most cases, however, experienced designers have depended upon their judgment to not exceed the limit of curvature fixed by the Schwedler principle, rather than upon the formula itself, which is somewhat tedious of application.

So far as the writer is able to discern, the most objectionable feature attending the curvature of chords is the reversal of stress in the vertical posts, which will always occur when a certain degree of curvature is exceeded. It is quite generally conceded that reversal of stress in any member of a bridge truss is a condition to be avoided whenever possible. Not only is the metal more severely fatigued by the reversal of stress, but when it occurs in a pin connected member, in which there is necessarily some clearance or play in each pin-hole, the reversal of stress is accompanied by a shock or blow, the effect of which, though probably small, is not known.

Making this condition the criterion of the limit of curvature, the writer will propose a formula for the curvature of chords which can be much more easily applied than the Schwedler formula, and which he believes to possess very practical value. As the ratio of the relative intensities of the live and dead load, which forms the basis of the Schwedler formula, is seldom accurately determined, in designing it becomes necessary to always make the curvature of the chord somewhat less than the limit given by the formula. The designer applies the Schwedler formula as a general guide, then uses his judgment in determining the actual curvature, making it always somewhat less than given by the formula. On the other hand, the formulas here proposed may be safely applied at their limits.

The following discussion refers to through bridges under the usual assumptions for uniform load. The entire dead load is assumed to be concentrated at the joints of the lower chord. Let the accompanying figure represent any truss of the Pratt type. Live load tension will occur in a vertical post when the truss is fully loaded, if at all. As a truss always carries its full dead load, the assumption for dead load made above gives a similar condition for the dead load tension in a vertical post.



With the truss fully loaded, let certain letters represent certain values, as follows:

S=total shear in any panel in the left half of the truss.
H=horizontal component of stress in upper chord in same panel.
V=vertical component of same.
v=vertical projection, or curvature, of inclined upper chord in same panel, downward toward reaction.
h=height of truss at vertical post at right of same panel.
m=number of panels at left of same vertical post.
m′=number of panels at right of same.
m + m =number of panels in truss.
p=panel length.
W=panel load.
R=the reaction of left support.

The stresses in the panel *c d* of the truss represented in the figure will now be considered. The following values are readily written:

$$R = \frac{W(m+m'-1)}{2}. \qquad (1).$$

$$H = \frac{R\,m\,p - W(m-1).\frac{1}{2}m\,p}{h} = \frac{W\,p\,m\,m'}{2\,h}. \qquad (2).$$

$$V = \frac{W\,p\,m\,m'}{2\,h} \times \frac{v}{p} = \frac{W\,v\,m\,m'}{2\,h}. \qquad (3).$$

$$S = W\left[\frac{m+m'-1}{2} - (m-1)\right] = W\frac{m'-m+1}{2}. \qquad (4).$$

If it be assumed that the inclination of the chord CD is such that the stress in the vertical post Dd is zero (the limiting condition of the curvature), then the amount of shear borne by the tie Cd will be equal to the single panel load concentrated at d only; the remainder of the shear in the panel, =S—W, will be taken by the vertical component V of the stress in the inclined chord CD. Hence,

$$V = S - W = W\left[\frac{m'-m+1}{2} - 1\right] = W\frac{m'-m-1}{2}. \qquad (5).$$

By equating the values of V as expressed in equations (3) and (5) we obtain:

$$\frac{W\,v\,m\,m'}{2\,h} = \frac{W(m'-m-1)}{2}$$

$$v = \frac{h\,(m'-m-1)}{m\,m'}. \qquad (6).$$

Equation (6) expresses the limit of the inclination of the chord in any panel to which it is applied, under the assumption made above. This formula is extremely simple in its application, being a function of the height of truss at the vertical post on the right of the panel under consideration and the number of panels at the right and at the left of the same post. The outline obtained for the truss is very graceful, while a high degree of both economy and stability is attained.

In a fully loaded truss having an even number of panels, the total shear in each panel adjacent to the center cannot exceed one-half panel load. Hence, when the center post carries no stress, the amount of shear carried by the tie in the first panel at the left of the center will be one-half panel load. As the formula deduced above assumes the tie in each panel to carry one panel load of shear, it is obvious that it does not practically apply at the center post; if applied at this post the result would be negative, indicating that in the center panels the chord should incline upward toward the reactions. In a truss having an even number of panels, therefore, the chord must be horizontal in the two center panels, and the formula is first applied at the first post at the left of the center.

If the formula be applied at the post adjacent to the center panel, in a truss having an odd number of panels, the result will always be zero. In a truss having an odd number of panels, therefore, the chord must be horizontal through the three center panels, and the formula is first applied at the first post at the left of these three panels.

In all other panels of any truss the chord may be inclined to the full limit given by the formula, as this will actually leave a margin of compression in each post equal to about one-third panel load of dead load. For it was assumed above that each entire panel load of dead load is concentrated at a joint of the lower chord, while actually about one-third of the panel load comes upon the post from the upper chord and lateral system. It is, therefore, unnecessary to allow any margin of safety within the limit of curvature given by the formula. There is, indeed, some advantage in designing to the limits fixed by the formula, as it will then be known that just one panel load of dead load shear is borne by the tie in each panel, except in the two center panels of a truss having an even number of panels, as noticed above. Consequently, with the exception just mentioned, exactly one panel load of negative dead load shear is to be deducted from the positive live load shear for the counter stress in each panel at the right of the center. This will usually somewhat increase the number of counters required, which is advantageous rather than otherwise, as it adds considerably to the stability of the truss, and does not materially detract from its economy.

Let the height of truss at Dd in the figure be 24 ft. By applying equation (6) at this post, the values of m and m′ will be 3 and 5 respectively, and the rise v of the chord CD is found to be $\frac{24 \times (5-4)}{3 \times 5} = 1.6$ ft. Hence, the height of truss at Cc is 24 – 1.6=22.4 ft. By applying the formula at Cc, the rise of the chord in the panel BC is found to be $\frac{22.4 \times (6-3)}{2 \times 6} = 5.6$ ft., and the height of truss at Bb is 22.4 – 5.6=16.8 ft. With these relative heights, it will be found that, with the truss fully loaded or carrying its dead load only, the ties Bc and Cd will each carry just one panel load of shear, while, with the same condition of load, the stress is Cc or Dd will be zero or, really, according to the assumption for the concentrations of the dead load, compression equal to one-third panel load of dead load.

For the form of truss in which the panels are divided by means of short diagonal struts extending from the center of each tie to the adjacent joint of the lower chord next toward the reaction, i. e., the Baltimore type of truss, the formula for the limit of curvature is

$$v = \frac{h\,(m'-m-2)}{m\,m'}. \qquad (7)$$

For the form of truss commonly known as the half hitch truss, in which each panel is divided by means of a short diagonal tie extending from the center of the main tie to the adjacent joint of the upper chord, toward the center of the truss, the formula for the limit of curvature becomes:

$$v = \frac{h\,(m'-m)}{m\,2+m'}. \qquad (8)$$

Although equations (7) and (8) must be applied at the vertical posts at the right of the full or

double panels, the values of m, m′ and v relate to the single or divided panels. Consequently, the value obtained for v must be doubled for the amount of rise or curvature of the chord in the double panel.

Equations (7) and (8) are deduced in the same general manner given for equation (6). It is not thought necessary to here give the process in detail. The accuracy of the equations may readily be proved by applying them. A comparison of equations (6), (7) and (8) will show that the amount of permissible curvature is the least for the Baltimore type of truss and greatest for the half hitch truss. For long spans, the latter is probably the most economical though, perhaps, not the best form of truss.

As previously stated, these formulas are believed to possess practical value. By designing each form of truss to the limit of curvature given by the formula, the calculations of the stresses may be made very simple. But this feature will not be discussed in the present article.

THE CYCLOTOMIC TRANSIT.*

By Otto von Geldern.

The evolution of the cyclotomic instrument is due to a constant tendency to create a transit with one spindle, i. e., having but one central cone turning within the leveling head, that shall, at the same time, sacrifice none of the advantages that the so-called compound center possesses.

It goes without saying that the principal advantage of the double spindle lies in the fact that, no matter in what direction the telescope may be pointed, the operator is enabled to make any azimuth of his graduated plate agree therewith. How this may be done without giving the lower plate an independent motion around the vertical axis of the instrument, is the problem to be solved.

The lower plate is the important member that carries the graduated azimuth circle, and if it be made a part of the rigid substructure of the leveling-head and base-plate, the control of it in reference to known azimuths is apparently lost. If we were enabled, however, to shift the figure series—the nomenclature of the circle—at will, so as to make any one of the graduation lines the zero, the advantage lost by having a rigid lower plate would be regained.

The novelty of the new transit lies in a floating exterior ring, placed around the periphery of the lower plate, upon which the figures from 0 to 360 are engraved. These figures are then no longer a fixed part of the circle, but possess that independent motion which the lower plate had in the case of the double spindle. Instead of turning the whole plate around the vertical axis, we turn a narrow metal band around the stationary plate, which is the same thing. As this band appears to be sliced from the plate, the name "cyclotome" has been applied to it, from the Greek words, kuklos, meaning a ring or circle, and temnein, the verb, to cut—that is, a ring cut or severed as from a disk. Since the object of the ring is merely to designate the graduated lines upon the plate by corresponding figures, absolute concentricity of the cyclotome is not a matter of importance.

Fig. 1 shows a vertical section through the plates, and Figs. 2 and 3, a top and a bottom view respectively of the upper plate. In the vertical section the arrangement of the principal parts may be readily understood. The lower plate and the leveling-head become one member, which is mounted upon the base-plate in the ordinary manner. The cyclotome C is fitted exteriorly around the plate, its top resting upon the graduation of which it is a part. The upper plate revolves upon the lower by means of its long and stout spindle, within the socket of the leveling-head. It carries the vernier V, visible through an opening in the plate, which also exposes an arc of the graduation of the lower plate and a part of the cyclotome. The horizontal motion of the instrument is arrested by the clamp and collar, and the position adjusted by a tangent screw, as in all transits. Compass circle, needle and telescope are mounted on the top of the plate as usual.

The flange forming the top of the lower plate is graduated into 720 even spaces of half-degree divisions. The vernier moves along the inner rim of this graduation, and may be held whenever the line of collimation (the telescope) has the desired direction. If, after clamping the plate, the zero of the vernier does not coincide with one of the half-degree division lines, it may be made to do so by means of the adjusting screw A, shown in the illustrations, which allows of a slight displacement of the vernier to the right or left in the manner presently to be explained.

In this wise we indicate that a particular one of the 720 lines shall be the initial or starter from which an arc is to be measured. And having determined upon and indicated the initial or starting line, it would be necessary only to bring the zero to the cyclotome—or any other reading for that matter—to match this line. The ring, therefore, plays the part of a tell-tale, or indicator, nothing more.

In the simpler form of the new transit, the exterior ring or cyclotome is revolvable by hand around the periphery of the plate, and the required reading is thus readily set off. In the improved form, as shown by the illustrations, the ring is encased, so that it cannot possibly shift its position inadvertently, and so arranged that the upper plate may or may not carry the cyclotome with it. It is picked up and revolved with the plate, or left at rest upon the lower plate in any desired position. It is within the power of the operator to manipulate this at will, and there are two means of doing so, as will be noted further on.

It is generally required to place the zero upon the azimuth from which observations are started. In order to accomplish this rapidly, an automatic catch L (see Fig 3), having a small projecting pin n, is so arranged that whenever it is desired to make the cyclotome travel together with the upper plate, the pin n must be made to drop into a hole provided for it in the cyclotome; the moment this takes place the two (plate and cyclotome) are connected, and—this is a peculiar feature of the device—in such a position that the zero of the vernier V,

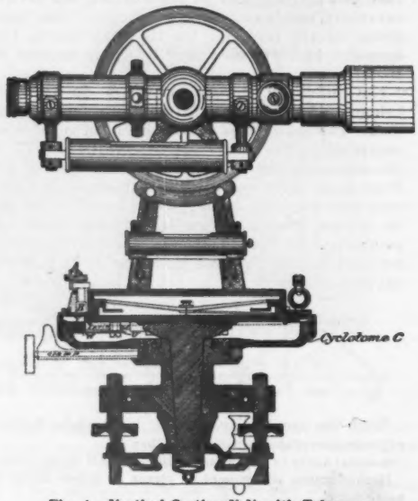


Fig. 1.—Vertical Section X-Y with Telescope in Elevation.

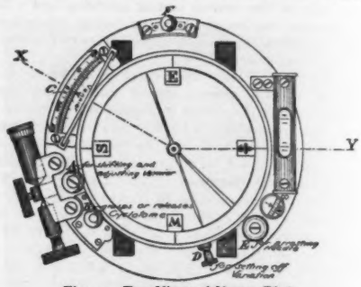


Fig. 2.—Top View of Upper Plate.

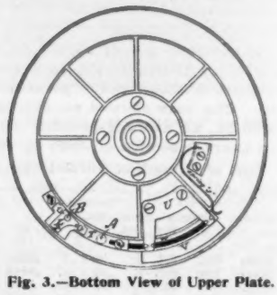


Fig. 3.—Bottom View of Upper Plate.

THE CYCLOTOMIC TRANSIT.

and the zero of the cyclotome C are brought to a radial alinement, separated, of course, by the intervening graduated flange of the lower plate. If the vernier be now revolved with the upper plate, the figure-system will turn with it, their respective zeros coinciding.

The bottom of the upper plate, Fig. 3, illustrates the mechanism with which this is accomplished. U is a guide, fastened to the plate, for the arc W, carrying the vernier V. A strong spring S presses the arc against the slide T, the position of the whole being regulated by the exterior screw A, which allows the adjustment of the vernier already referred to. The catch L is poised in T. The screw B raises or lowers the catch, so that with it we may throw the cyclotome either in or out. A small spring under the catch L admits of this. The mechanism is so simple that it needs no further description. In fact any other arrangement might be readily substituted to meet the same end. With this device there is no difficulty in placing the zero of the horizontal circle so as to correspond with any pointing of the telescope.

The field manipulation is reduced to a minimum. Having set the instrument over a point (1) in the usual manner, it is desired to direct the telescope to another point (2), and to make the zero of the horizontal graduation correspond with this azimuth. The main clamp being loose, the first operation is to turn the screw B so that the catch L is depressed; the upper plate is then turned, until a click indicates that the little pin has caught the cyclotome and is carrying it along, with the zero in position as explained. The operation is automatic to this extent, that the manipulator need not watch his plate to set the zeros. He will now direct the telescope to point (2), clamp the plate, and bisect the object with the tangent screw. His attention is thereupon directed to the vernier, for it is essential that its zero should correspond exactly with a line of the fixed graduation. He turns the screw A to the right or left, shifting the vernier sufficiently to accomplish this. The cyclotome travels with the vernier, so that he does not need to watch it. The instrument is now oriented, the vernier indicating the starting azimuth, and measurements to other points may begin. Before commencing, however, the screw B is turned so as to release the catch and allow the cyclotome to remain in position. The instrument is now unclamped and ready for operation. A subsequent reading will indicate directly in degrees and minutes the deflection from the starting point. The cyclotome rests securely upon the lower plate and is guarded against any possible displacement. The whole operation is simple and rapid, and will require less time than the setting of the compound-center instrument.

If it be desired to set any other reading to a telescope pointing, recourse is had to the clamp F (see top view of plate, Fig. 2,) by which the cyclotome may be connected to the upper plate at any point. The operation is as follows: Set up instrument; drop catch L by a turn of screw B; revolve plate on center, click indicates that L has caught cyclotome C; point telescope, clamp plate and bisect object; shift zeros to the nearest graduation line by screw A; release cyclotome by screw B; unclamp instrument and lay off the reading of the required azimuth to the nearest 30′ by means of the clamp and tangent screws, and then to the minute with precision by means of the screw A; now turn down the screw F,

which catches the cyclotome; unclamp instrument, revolve on center, direct telescope to original object, clamp and bisect. The reading of the vernier will now indicate the azimuth wanted. Release the screw F and the cyclotome will remain in the position into which it has been brought.

The reason why the reading is laid off to the nearest 30 mark only, and then adjusted to precise reading by shifting the vernier, becomes obvious if we remember that it is always necessary to match the graduation lines of the plate with those of the cyclotome, and that any setting disturbing their coincidence (readings from 1′ to 29′ and 31′ to 59′) will have to be corrected by a vernier displacement.

This operation is rapid, although perhaps a trifle slower than the manipulation with the earlier hand cyclotome, mentioned above, in which case the telescope is directed, plate clamped, object bisected, vernier zero brought to a line, cyclotome turned by hand to read within the nearest half degree of the line, after which the vernier is adjusted to the exact reading. The principle remains the same in either method, the only difference being that in the case of the hand cyclotome we are able to set it irrespective of the motions of the upper plate. After these explanations it becomes very obvious that there are no advantages that the double spindle system can claim over the cyclotomic system in this particular.

The utility and practicability of the instrument have been tested in the field upon extensive engineering works during the last year. It has fully met all demands made upon it. In the matter of placing the zeros on the first or starting object, it has been shown by actual trial that, with a little practice, the cyclotomic transit may be set more rapidly and expeditiously than the double center instrument. The mechanism is so arranged that the vernier, once properly set, may be automatically locked, without any possibility of displacement, until the operator desires to release it again. The cyclotome, too, cannot be displaced after it has been dropped into position; and were it to occur, the operator would be instantly aware of it, for the required coincidence between lines would be disturbed.

*A paper read before the Technical Society of the Pacific Coast.

These arrangements and the absolutely stationary graduation afford a fixed repose to the azimuth circle that the double center instrument does not possess, for the least shock or touch may displace the contact between its outer spindle and the leveling head, and disturb the original setting of the plate.

In its optical appointments and constructive details, the instrument may be brought fully up to the standard of a first-class modern transit and surveying instrument; it may be a tachymeter and, in fact, fitted for any possible expediency of modern engineering. It has not been the object to replace the compound center instrument with a cheap and inferior substitute, but rather to simplify the required parts and to improve, if possible, the stability and concentricity, without losing those features that have thus far made the double-center instrument the preferred one for meeting the manifold demands made by the profession upon a universal measuring tool.

As to the advantages of the cyclotomic transit, the main feature is its single spindle. Its adoption obviates the necessity of the lower clamp and tangent screws, and simplifies this part of the transit very much. It affords an opportunity to bring the plates closer to the leveling head, thereby lowering the center of gravity of the instrument. It sits directly upon the rigid substructure, fitted into it by a thick metal axis, and must therefore be very steady. The main graduation, the most vital part of the transit, is fixed for all time. Once properly centered, the chances of eccentricity are reduced to an absolute minimum. The instrument possesses a comparing vernier, opposite the reading vernier (see Fig 2), which shows through a circular opening in the plate. By means of the two, used in conjunction, the plate eccentricity may be accurately determined, which is another advantage of the instrument.

What is justly claimed for this instrument as more advantageous than the compound-center transit is included in the following: Greater simplicity; reduction of parts and reduction of weight, with greater steadiness for instruments of the same size; greater solidity of the axis, and therefore greater rigidity, and the least liability to serious injury through accident; simple mechanism, enabling a more rapid setting of the plates to the zero azimuth; avoiding the manufacture of an extra cone or socket—that is, reduction of prominent and costly parts to be made by the artisan, and a reduction, therefore, of the price of the article.

While the repetition of an angle, resorted to in geodetic surveying, to obtain the value of an arc with its probable error to the fractional part of a second, is not possible with the cyclotomic transit, because the main graduation is fixed and cannot be turned in reference to the direction of the objects observed upon, it is perfectly feasible to take the same angle on different parts of the plate.

Unless a double spindle transit be of the very best workmanship—that is, first-class and therefore a high-priced article, all the reiteration and repetition will fail to reach a better result than that attainable with a well-built cyclotomic transit, which is made to read to half minutes directly, or to twenty seconds in the larger sizes; and anything within the limits of this accuracy is guaranteed by the maker. As the repetition of an angle is uncalled for in any but the most refined measurements, the cyclotomic transit suffers nothing for the want of this particular feature.

The instrument in its present shape was designed in detail by Mr. Adolph Lietz, of San Francisco, the original suggestion having been made to him by Mr. Luther Wagoner, Civil Engineer, who had conceived the application of the floating ring or cyclotome. All rights have been legally secured by the designer, who is also the manufacturer. The cyclotomic transit is particularly adapted to aluminum construction, by placing a light superstructure upon a firm and solid base. This will insure very great steadiness even in a strong wind.

The principle here made use of may be extended with advantage to many forms of are measuring apparatus, and will undoubtedly find a much wider application in time. Although extremely simple and readily understood by any one, it will require a little field practice to make the engineer an expert in the use of the cyclotome, which, like the slide-rule, will be appreciated all the more and its advantages become apparent the longer it is used.

STANDARD PHYSICAL TESTS FOR THE PRODUCT OF THE BLAST FURNACE AND THEIR VALUE.

At the Pittsburg meeting of the American Institute of Mining Engineers, Mr. Thomas D. West, of Sharpsville, Pa., presented a paper with the above title, the principal part of which is devoted to giving detailed directions for molding and casting the 1⅛-in. round test bars, for transverse tests, which shape and size he prefers to the square bars advocated by other experts on the tests of cast iron. The following extract from his paper gives his opinion of the value to the furnace-owner of making both chemical and physical tests of his product:

True progress in making and mixing cast iron dates from the time the maker and user of pig metal commenced the use of chemistry. All who have closely followed the history of chemical combined with physical tests for the past two years will confess that they mutually aid each other, the former telling the constituents of iron, and the latter the effect which their combination produces. Progress in the science of either making or mixing iron requires the study of the physical as well as the chemical properties.

Two years ago, when few furnaces making foundry iron, or foundries using it, were utilizing chemistry, the writer predicted it would not be long ere the furnaces, at least, would all have laboratories. This has largely come to pass, and the writer believes it will not be long before all will take the same interest in the question of physical tests as is now taken in chemical ones.

The day is past for tolerating the blind, ignorant practice which we foundrymen followed a few years back in mixing iron. The wonder is that we ever "hit" what we wanted, when we consider how deceptive is the fracture of pig metal as guide to its true "grade." I am aware that only about one-tenth of our present founders have kept up with the progress of utilizing chemistry in mixing their iron; nevertheless, I say, when the furnace-man has done his part, let the founder study to do his by calling chemistry to his aid, or else get out of the business and stop his growling about "bad iron."

There is no "bad iron." All can be utilized in some class of work or other. All that is wanted is a knowledge of its chemical and physical properties, and when the furnace-man and founder understood these as they should do, pig iron of any grade or quality need never be shipped in the wrong direction. It is simply a question of "carding the car" right, to have a furnace-man clean his yards, and have no complaint about his iron, however "bad" he may occasionally make it.

SOME ENGLISH PATTERNS OF LIGHT DRAFT DREDGING MACHINES.

In another column of this issue will be found some discussion of the relative merits of English and American types of dredges, and we show here-

Fig. 1.—Dredge for the Thames Conservancy Board.

with some interesting examples of light draft English dredges of the ladder type built by Hunter & English of London.

The dredge shown in Fig. 1 was built for the Thames Conservancy Board, and is designed to dredge to a depth of 15 ft. of water on a draft of 3 ft., delivering 70 tons of material per hour into barges alongside. It has a high pressure horizontal engine, and a return tube multitubular boiler. Its cost was about $25,750.

The dredge shown in Fig. 2 was designed specially for work in small canals, the buckets delivering the material onto a conveyor discharging into barges astern of the dredge, so as not to interfere with the passage of boats. The ladder frame and tipping head are made to lower by means of the sheer legs (which also turn down) so as to enable the dredge to pass under bridges with only 11 ft. headway. It cuts its own way, excavating 40 cu. yds. per hour, and giving 6 ft. of water, and also forms the slopes of the canal banks. The cost was about $13,500.

Fig. 2.—Ladder Dredge with Stern Discharge, for Small Canals.

A large dredge of very shallow draft is shown in Fig. 3. It will dredge to a depth of 12 ft. of water on a working draft of 15 ins., excavating 70 tons of material per hour. It will deliver the material either into barges alongside or onto the

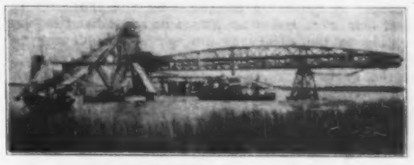


Fig. 3.—Light Draft Ladder Dredge with Shore Conveyor.

bank, 90 ft. distant, by a belt conveyor carried by a pair of through lattice girders supported by pontoons. This machine is said to have been remarkably economical in its working. It is fitted with horizontal compound surface-condensing engines and a return tube multitubular boiler. The cost was about $34,500.

A large dredge built by the same firm for work on Lake Copais, in Greece, has a draft of only 3 ft. but dredges to a depth of 22 ft. of water, excavating 170 tons of material per hour and delivering it onto one or other of two belt carveyors, carried by deck trusses 85 ft. long projecting from the sides of the dredge and supported by guys from derrick frames. The cost of work done by this machine is said to be only 3 cts. per ton, delivered. The dredge is fitted with compound surface-condensing marine engines of 90-I. HP., and a horizontal return tube multitubular boiler. The cost was about $53,350.

Some other small ladder dredges of light draft were referred to in our issue of Nov. 7, 1895.

THE RECLAMATION OF WATER FRONT along the Atlantic sea coast at Long Branch, Asbury Park and Belmar, N. J., is proposed by an English syndicate now being organized. The incentive is the good work done at Atlantic City, N. J., by the use of jetties made of brush mattresses loaded with stone. By means of these jetties the government saved the Absecon lighthouse at that point, and the jetties there have advanced the beach front over three-quarters of a mile seaward within four years. The syndicate hopes to do the same at other points along the coast, and will buy up what is now comparatively worthless water front and protect it in a similar manner.

THE WALRAND-LEGENISEL STEEL PROCESS.*

By H. L. Hollis, M. Am. Inst. M. E.

The paper read by Mr. George J. Snelus in 1894 before the Iron and Steel Institute of Great Britain, so fully and ably described the Walrand-Legenisel process, that there remains very little to add beyond recording some changes since then in practice, which the writer observed last summer at several continental works, and to state that this process has now been for some time in successful operation in the United States.

Briefly stated, the Walrand-Legenisel process is an addition to the Bessemer operation, with the object of obtaining quiet and more fluid steel, and consequently sound castings and ingots. This is achieved by adding ferro-silicon at approximately the time of flame-drop in the ordinary Bessemer operation, and making an after-blow. The high calorific power of silicon is well known, and the rapid combustion of it immediately before pouring raises the temperature of the steel most notably, and, what is further, finishes the steel-making operation by the combustion of silicon to a solid (slag), instead of carbon to a gas. The high temperature thus obtained and the consequent fluidity of the steel is well shown by the very small and intricate castings, running down to a fraction of a pound in weight, which are regularly made; but perhaps the best indication of the heat of the steel is shown by the fact that as small charges as 6,000 lbs. have been blown successfully for several years at Paris, and often the charge has been poured entirely into small work, taking from 15 to 25 minutes, without a sign of skull in the ladles. At the Potter & Hollis Foundry Co.'s plant, Chicago, heats 1,000 to 1,200

*Abstract of a paper read at the Pittsburg meeting of the American Institute of Mining Engineers, February, 1896.

lbs. of steel have often been poured by means of two hand ladles of 100 lbs. capacity (necessitating refilling each five or six times) and not less than 20 minutes taken for the casting, and yet the ladles would be entirely free from skull at the end.

The details of practice vary considerably at the different works where this process is employed, but the features in common are briefly these: The vessels employed are the usual type of bottom-blown Bessemer converters. The blowing is continued until about the time of flame-drop, when the vessel is turned down and ferro-silicon (containing 10 to 12% silicon) is added. An after-blow is then made, the time for terminating which varies at different works. After this, ferro-manganese or spiegel is added for recarbonising and the steel is poured into large ladles on cranes or small hand ladles, according to the nature of the work. The blowing is generally controlled by aid of the spectroscope.

At the works of Eugene Legenisel in Paris there are two converters, one of 1,200 lbs. and one of 600 lbs. capacity. The sprues and heads and all steel scrap are melted with the pig iron in the cupola and every cupola charge consists, after the first one or two heats, of about 80% pig and 20% steel scrap. The ferro-silicon and spiegel additions are melted in small cupolas and added to the converter by means of ladles. In blowing, the converter is turned down the first time just short of flame-drop so as to leave enough carbon to act as an index in the spectrum of the after-blow. The silicon in the steel very seldom exceeds .05% and often runs down as low as .02%. A large part of the small work is cast in green sand. At the works of the Messrs. Schneider, Le-Creuzot, there is one 1,500-lb. converter. The steel scrap is added directly to the converter and the ferro-silicon and ferro-manganese are heated red, but not melted. The spectroscope is used to control the blowing as at Paris, but the vessel is turned down earlier in the after-blow and the aim is to have 0.20% silicon in the steel. At Hagan, Westphalia, there two 1,200-lb. converters. The blowing here is continued to the flame-drop for the first turning down and the after-blow is regulated more by time and the general appearance of the flame than by the spectroscope. The Potter & Hollis Foundry Co., Chicago, has had for several months one 1,500-lb. converter in operation and another one is now being added. The steel scrap is added entirely to the cupola mixture and the ferro-silicon and spiegel are added molten. The blowing is controlled practically the same as at Paris. The most important change in practice is in the blast pressure. On the Continent very high pressures are employed—up to 30 lbs. per sq. in.—while at Chicago not over 10 lbs. has been used. Melting the additions in crucibles, as at Hagan, and in small cupolas, as at Paris, have been tried and the former certainly is more satisfactory.

The steel made by this process is most satisfactory in every respect. Entirely sound castings of any size, up to the capacity of the vessel, as well as ingots, are obtained and the steel shows high physical tests. The carbon, manganese and silicon are entirely under control, the first two being regulated by the added spiegel and the latter by the blowing; the phosphorus and sulphur depend, of course, on the stock. Successive heats can be blown with practically identical compositions. At the Chicago plant the composition for the usual run of castings is from 0.25% to 0.30% carbon, between 0.10% and 0.20% silicon and about 0.60% manganese. Such steel will give unannealed 75,000 to 80,000 lbs. tensile strength per sq. in., with 5% elongation in 8 ins., and 70,000 to 75,000 lbs. tensile strength with 12% elongation in 8 ins. annealed. The experience so often quoted of obtaining less sound castings as the temperature of the steel rises is entirely reversed and it is found that the hotter the steel the more solid and more satisfactory in every way are the castings.

A word in regard to the silicon in this steel: While it is possible to run the silicon down for regular practice as low as 0.5%, it is found that nothing is gained by doing this, so far as castings are concerned. By increasing the silicon (to even as high as 0.50%) the tensile strength is much raised without appreciably lowering the elongation. Tests for magnetic permeability have been made with this steel, containing over 0.30% carbon and with manganese above 1%, which have given the very best results.

The only trial of this process with large vessels that has come to the attention of the writer, is a number of heats which were blown in 8-ton vessels at Les Acieries de France, last summer. Here the object was to obtain soft steel for wire and the resulting product showed below 0.02% silicon, 0.13% carbon, and 0.20% manganese, the physical test running about 50,000 lbs. tensile strength, with 27% elongation.

While it may be unwise to conjecture uses for this process in advance of actual trials it would seem not improbable that where the increased solidity of the ingots justified the small additional cost it would have a future in connection with operating large Bessemer plants. It has most certainly demonstrated its value in making steel castings.

To summarize what may be justly claimed for this process up to the present time: (1) It furnishes a steel foundry with exceeding fluid, quiet steel in quantities and at such intervals as are best adapted to the work to be poured. (2) It makes possible castings successfully small and intricate pieces of steel. (3) Green sand molds can be used with most satisfactory results, the steel being so fluid and holding its temperature so well that it can be poured slowly over a lip, and in this way not tear a green sand mold and not carry in air, as is the case so often when bottom-pouring is employed. It should be said, however, that when castings have to be machined for a perfect surface, it is better to use dry sand molds, for with green sand there is an unavoidable "pinholding" at times in from the surface. (4) The relative small cost of installation and the fact that a converter can be heated up in an hour ready for use, makes it unnecessary to operate the plant continuously to obtain economical or satisfactory results.

It should be added that M. Walrand claims the same results in the basic process by substituting a high phosphorus iron for the ferro-silicon addition, but with this the writer has had no experience.

PROGRESS OF THE GOVERNMENT TIMBER TESTS.

The investigations and tests of American timbers, undertaken by the Forestry Division of the U. S. Government, are of special interest and value to engineers, and we are enabled to publish herewith a letter received by Mr. Walter G. Berg, Principal Assistant Engineer of the Lehigh Valley R. R., from Mr. B. E. Fernow, Chief of the Division of Forestry, in which the general progress and prospects of the work are briefly stated:

The total number of tests made at the mechanical laboratory, to Jan. 31, was 39,437, which during February was brought up to about 41,500, when all the material collected was tested and the work for the present abandoned, under the orders of the Secretary of Agriculture. In the above number the moisture determinations which accompany the tests are included, reducing the actual number of mechanical tests to probably 35,000. The material for these tests was specially collected in the woods, comprising 356 trees, representing 32 species, mainly of southern growth. The distribution of tests by species stands as follows:

Southern pines (5 species)	20,341		
Northern pines (2 species)	1,097		
Bald cypress	4,126		
White cedar	243		
Oregon fir (10 species)	276	(1)26,083	
Gum (red)	867		
Oaks, white (4 species)	4,052		
Oaks, black (5 species)	4,301		
Hickory (8 species)	3,011		
Ash (2 species)	714		
Elm (2 species)	400	13,354	
Total			39,437

(1)Conifers.

Of northern timbers, only the white and Norway pines have been tested in a small way; and of Oregon fir, only a few random sticks sent in by an interested party; all others are southern.

Of these sticks only a portion on longleaf pine was compiled and worked up in Bulletin 8. There are, however, now the entire data on southern pine worked up in manuscript. The average results will presently be stated in an eight page circular, the status of the printing fund of the department preventing, for the present, the issue of a full bulletin. There will then still remain nearly as many data referring to other species undigested.

You will, however, understand that this test work differs from other testing done hitherto, in that it places reliance only on large numbers. Hence, for instance, the 276 tests on Oregon fir would hardly warrant us in drawing any conclusions, they are not better than any other tests, except that their moisture condition is noted, which is, to be sure, one important advantage. On the other hand, for the southern pines we may claim to have such a series of data as to make it unnecessary for anybody else to test these timbers again; they cover such a large number, under all sorts of conditions, that absolute confidence in the reliability of the data for the range of strength in the species should be accorded to them.

At the same time the confusion existing in engineers' tables with regard to the kind of pine (names or species) should not be permitted any longer, especially since the various species promiscuously referred to as southern pine, yellow pine, pitch pine, etc., differ up to 20% in average strength values. But the mere establishment of the strength values does not exhaust the usefulness of these data; they were to be used, and will be used, if we are permitted to establish such relationships as will lead to the formulation of "rules of inspection," which is the most important object of these investigations, as a result of which the engineer or other consumer will be enabled to judge of the comparative value of the piece in hand. For such purpose the existing data may sometimes not even prove sufficient and would have to be supplemented by new data obtained under special conditions.

One of the investigations of this nature directly interesting to the engineer is that on the relation of tests on large and small sizes. Here, too, our number of tests is still too small for safe generalization, although not less than 340 large columns and beams have been tested with the interesting and readily explained result that for symmetrically cut beams (heart in center) the values are as large and sometimes larger than for the average of the small pieces cut from the same beams; while the columns give mostly but not always lower values, yet the results are so variable that no trustworthy numerical data have been attained; the range in individual cases being as much as 50%.

At present the work will be abandoned for the fiscal year, the allotment of funds having been exhausted, about $40,000 in all having been spent so far. An attempt to work up the test results, at least for data of strength, will be made. In the reading of the appropriations for this division, for the next year, the reference to this line of work has been left out and a discontinuance is probably contemplated. A bill making special appropriation for its continuance has been introduced in the Senate (S. 1214), but its passage is exceedingly questionable. I regret that I cannot report to you a more hopeful outlook.

NOTES IN FOUR WESTERN CITIES.

(Editorial Correspondence.)

The following notes were taken by a member of the staff of this journal in Des Moines, Omaha, Minneapolis and St. Paul, in January, and relate principally to municipal engineering and allied subjects.

Des Moines.—The street railway system of Des Moines is remarkably well adapted to the wants of a city of some 60,000 people spread over 54 sq. miles of territory. All cars pass around a loop in the center of the city, and the tracks radiate from this loop through valleys and over hills to every part of the city. This loop plan obviates double track in the crowded business streets and simplifies the transfer system. All transfers, with one exception are given at one point, where they may be obtained to any part of the city, and there a large waiting room is provided. Of the 32 cars in regular service, all but one passes around the loop.

The Des Moines City Railway Co. owns the street railways of the city, and Mr. G. B. Hippee is the manager of the company. Des Moines was one of the first cities in the United States to have an electric street railway. There are now 40 miles of track.

Des Moines is unique in its facilities for cheap brick pavements, and has taken advantage of the situation by putting in some 34 miles of brick out of a total of 43 miles of paving, the balance being nearly all cedar block. There are large deposits of fireclay within the city limits from which first-class paving brick are made, while beneath the clay is bituminous coal. This coal is mined, it is said, by some of the brickmakers for their own use.

Some of the largest manufacturers of paving brick are the Des Moines Brick Mfg. Co., the Iowa Brick Co. and the Flint Brick Co. A large part of the product is used locally, but many thousands of paving brick are being shipped to other cities, although the industry is still young in Des Moines.

In 1894 brick paving was put down in two layers on 6 ins. of sand with 1 in. of sand between layers and a sand filler, for only 99 cts. per sq. yd. In 1895 from $1.15 to $1.35 was paid for a similar class of work. One layer of brick on concrete foundation, with tar filler, cost from $1.45 to $1.65 per sq. yd., but some such pavement has been put down for $1.35.

About 10,900 ft. of 4-ft. two-ring brick sewers were begun in September, 1895, with Kavanagh & O'Connell as contractors. Some 4,500 ft. of this work is in tunnel, through various kinds of clay and stone at from 13 to 70 ft. below the surface. The open cut ranges from 13 to 4 ft. in depth. The contract price for the work was $4.47 per lin. ft. on the whole job.

The board of public works has charge of all city contracts exceeding $200, including even fire and police supplies. The board has only two members, Messrs. John Sherman and Geo. Simms. Mr. Frank Pelton is City Engineer, and Mr. Geo. M. King is one of his assistants.

Besides paving brick, other kinds of brick are made in large quantities, and also sewer pipe and drain tile. The largest manufacturer of the latter material is the Iowa Pipe & Tile Co., of which Mr. Chas. E. Rawson is Manager. This company has the largest output of tile and sewer pipe of any in the state.

Immense quantities of coal are mined within the city limits and in Polk County, of which Des Moines forms a part. The cheaper grades of steam coal sell at from 75 cts. to $1.50 a ton, delivered on cars, and lump coal for from $2 to $2.50 per ton.

Omaha.—Only a brief stop was made in Omaha, it being generally agreed inside and outside the city that all business interests were very much depressed owing to crop failures and hard times in the surrounding district.

About 1,500 sq. yds. of California Alcatraz paving were put down in Omaha last fall by Mr. Hugh Murphy. According to Mr. Andrew Rosewater, M. Am. Soc. C. E., until recently city engineer of Omaha, Mr. Murphy has one of the most complete asphalt plants in the country. Oil is used for his furnaces, and the plant has a daily capacity for preparing material for 2,000 sq. yds. of pavement.

About three years ago Mr. Murphy laid a brick pavement on a semi-business street on a 10-year maintenance contract. If 25 per cent of the surface material is worn off at the end of the period it must be replaced. The price was $1.43 per sq. yd. on old concrete, one course of brick being laid on sand.

There are now about 400,000 sq. yds. of wood pavement in Omaha, which must soon be taken up. Most of this will probably be replaced with asphalt. There are now about 23 miles of asphalt in use.

Minneapolis.—Good progress was made on the new dam across the Mississippi River at Minneapolis in 1895. The dam is being built by the St. Anthony Falls Water Power Co., under the direction of Mr. Wm. De la Barre, M. Am. Soc. C. E., Chief Engineer of the company. Before work was shut down for the winter the retaining walls of the head and tail races, the excavations for the latter, the foundations and substructure of the power house, a 50-ft. section of the dam, concrete foundation for 475 ft. more, and two 50-ft. bear-trap gates had been completed. The head and tail races will be 210 ft. in length each, and the power house 54 × 235 ft., inside. It is proposed to put in 40 turbines, 42 ins. in diameter, and to develop from 3,000 to 10,000 HP., according to the stage of water in the river. The work already done has cost $155,000. It is estimated that the dam and power house, fully equipped with turbines and electric machinery, will cost $700,000.

The steam power for one-half the great flour mill, known as Washburn Mill A, is developed by the 1,250-HP. vertical triple expansion engine made at Elbing, Prussia, by F. Schichau and exhibited at the World's Columbian Exposition. The engine drives machinery which makes 4,400 bbls. of flour a day. It is run by steam at 160 lbs. pressure, and stops only from 6 a. m. to 6 p. m. Sundays. The engine drives a 11½-in. shaft at a speed of 110 revs. per minute, on which is a 15-ft. wheel with a 61-in. face carrying 20 2-in. rope drivers, 75 ft. from c. to c. of shafts, running at a speed of 5,229 ft. per minute. Steam is furnished by three 350-HP. Heine boilers with T. R. Bateman extension smokeless furnaces. Two boilers, or 660 HP., are used to drive the 1,250-HP. triple expansion engines. The other half of this big mill is run by a 1,000-HP. compound engine, made by Wright of Newburgh, N. Y. The boiler plant for this engine consists of ten tubular boilers, 65 ins. in diameter and 18 ft. in length.

It is expected that about 125,000 sq. yds. of paving will be put down in Minneapolis this season, of which 10,000 will be brick and the balance asphalt. Both brick and asphalt will be laid on 6 ins. of concrete, the brick having a sand cushion. After the work is completed the cost will be assessed on abutting property in five annual installments, the city paying for street intersections. A similar plan is followed for sewers, only the assessments are limited to $3.00 per lin. ft. of sewer, or $1.50 to each side of the street. All sewer work is done by day labor, quite a number of trained foremen being constantly employed and practically the same gang throughout.

About 3,000 ft. of sewer was built in 1895 with concrete invert and side walls and a brick arch, the latter being used in place of concrete on account of the lateness of the season, it being desired to pull centers and refill the trench as soon as possible. The sewer was 4½ ft. wide at the springing line, about 4 ft. wide at the bottom, with a sub-channel 30 ins. wide and 22 ins. deep, having a curved bottom. The concrete was from 12 to 14 ins. thick, and the brick arch was composed of two rings. At points the sewer was built in a 33-ft. trench. Empire Portland cement was used.

The accompanying illustration shows a street-cleaning device for hand use, employed in Minneapolis. Mr. Cappelen states that the device is also used at Milwaukee.

St. Paul.—This city has an extensive system of tunnels in which are laid water mains and telephone wires and which serve as sewers, the three classes of work, however, being entirely separate. This has resulted from the very favorable geological conditions at St. Paul, a soft sandstone underlying the city at various depths. The sandstone is so soft that it is loosened with picks. The tunnels are generally large enough so that

A "Boss Street Scraper."

a man can walk through them without stooping. The telephone wires are in lead pipes supported on the sides of the tunnel. The water mains are laid on the bottom of the tunnel. The sewers have brick channels at the base of the tunnels. Water and sewer house branches are made wholly or partly in tunnel, and water meters, when used, are located in the main tunnel, thus obviating the necessity of entering houses. The water main tunnel may be entered from the basement of the waterworks building and the sewer tunnels from the basement of the city hall.

There are also some sewer tunnels in Minneapolis and a number of tail race tunnels from the mills, all in the sandstone. There are some 20 miles of sewers and four miles of water mains in tunnels in St. Paul.

A city ordinance requires all wires in the business portion of the city to be underground by Jan. 1, 1897. Already the telephone wires in the business section are pretty well underground and some electric light wires have also been buried. To what extent these wires have been or will be put in tunnel cannot be stated here. The sewer tunnels are described in detail, and some information regarding the other tunnels is given by Mr. Geo. L. Wilson, M. Am. Soc. C. E., in the Transactions of that society for August, 1894.

Asphalt pavements on 6 ins. of concrete in St. Paul cost from $1.96 to $2.60 per sq. yd. in 1895. Some brick pavements may be laid in the coming summer.

Some old cedar block paving was renewed in 1895 at 77 cts. per sq. yd. The blocks were 6 ins. long, were laid on 2-in. plank, which also had to be renewed, and were graveled and tarred. The conditions for cheap work were favorable, as the contractors had a large amount of cedar on hand. It is said that with light traffic cedar will last eight years in St. Paul. Its life is longest on shady and wet streets. On one street cedar blocks have been down eleven years, and although in bad condition the property-owners think it will do for another year. Some new cedar block pavement was put down last year on 6 ins. of concrete. A fair price for such work in St. Paul would be $1.10 per sq. yd. Last year 4.8 miles, 2,000 sq. yds. in area, of cedar block were replaced by asphalt and about the same amount is needed this year.

The relative cost of asphalt paving to abutting property owners where there are and are not street railways is $3.72 and $6.81 per lin. ft., respectively, the street railway companies paying for the space between and for 2 ft. each side of their tracks. Mr. L. W. Rundlett is City Engineer of St. Paul and Mr. Geo. L. Wilson is assistant in charge of sewers.

Both Minneapolis and St. Paul are among the cities that have not yet solved the garbage disposal problem. Dr. Alex. J. Stone, Commissioner of Health for St. Paul, is alive to the needs of an improved system of collection and disposal of garbage and to reforms in other health matters.

Fielding & Shepley have the contract for collecting garbage. There are from 27,000 to 28,000 houses in the city. Garbage must be collected three times a week in the greater part of the city and six times in the more thickly settled and wholesale districts. Some houses are, of course, vacant, and others have as many as 30 inmates. The yearly contract price is $14,725, which is about 50 cts. a year for each house. Dr. Stone feels that this is too much work for the money received and that good results cannot be expected. The population of St. Paul, shown by a census taken in 1895, was about 140,000, an increase of only 7,000 in five years. Some of the garbage collected is fed to animals and some is burned, it all being hauled by cars to a point about 14 miles from the city. Dead animals collected by the contractor are sold to rendering establishments.

The health department has no control over garbage collection further than the power to impose a fine of 25 cts. for each failure to remove garbage, but this fine must be approved by the city council. No inspectors are employed and if good results are obtained the praise seems likely to be due the contractor and not the city.

At the office of Maj. W. A. Jones, U. S. A., Engineer in Charge of the Improvement of the Mississippi River above the Falls of St. Anthony, it was learned that the rainfall at St. Paul in 1895 was 24.26 ins. The total discharge of the river at that point in 1895 was 123,358,458,000 cu. ft., or on average discharge of 3,912 cu. ft. per sec. The month of minimum flow was January, when the average discharge was 1,538, and the maximum month was June, with an average flow of 7,556 cu. ft. per sec. The minimum flow for one day was 1,056 cu. ft. per sec. on Feb. 4 and the maximum 9,900 on June 15, 1895. The total flow of the river at St. Paul in 1895 was only 5% of the total rainfall on the drainage area.

The reservoir storage system for the headwaters of the Mississippi is now pretty well along. An estimate has been made for storing about 12,000,000,000 cu. ft. at Gull Lake. Messrs. Archibald O. Powell and Archibald Johnson are civilian assistant engineers to Maj. Jones.

Opportunity was had to visit only two industrial establishments in St. Paul. The American Hoist & Derrick Co., of which Mr. H. A. Wood is treasurer, have quite a plant here devoted to the production of hoisting machinery. The machine work is done on five floors, each 50 × 100 ft., besides which there are boiler shops, grey iron and brass foundries, and a warehouse. Pneumatic riveters, drills and calkers are used and many steel castings are now put into the company's products. A vertical boiler is made to go with the hoisting engines.

The Watrous Engine Works make all sorts of fire apparatus and also the Watrous fire hydrant. The company has a new shop 80 × 240 ft., which it is about to equip with a traveling crane.

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The paper on the Walrand-Legenisel Steel Process, given elsewhere in this issue, describes a most interesting modification of the ordinary Bessemer process, and one which promises to be of important service in the manufacture of steel castings. The chemical and thermal reactions of the Bessemer process having been so long well known, it seems remarkable that it should not hitherto have been tried to avoid the troubles which are occasioned by the gases present at the end of the blow by the addition of ferro-silicon and an after blow after the burning out of the carbon. The silicon burns to a liquid slag, instead of to a gas, as carbon does, and at the same time increases the fluidity of the metal, a matter of great importance in the manufacture of small castings.

The Board of Health of Lowell, Mass., apparently does not realize the fact that water purification and the use of meters naturally go together. The city has been trying to get away from the sewage-polluted Merrimack River as the source of its water supply by putting in a driven well plant, and has been striving to keep the water consumption down to the capacity of the wells by introducing meters extensively. The Board of Health urges that, instead of spending money for meters to reduce consumption, money should be paid out for filter beds to purify the Merrimack River water and thus by affording an unlimited supply encourage the use of water to the benefit of the health of the community.

Before the wells were put in the whole supply was drawn from the Merrimack River and typhoid fever ranged from being common to epidemic. The new supply, it appears, has been accompanied by a diminution in the typhoid death rate. During the cold weather the pumpage increased through the waste of water to prevent the freezing of plumbing, and the river had to be drawn upon. This was followed in due time by an increase in typhoid fever.

If recurrence must be had to the river at intervals, of course filters should be provided, but this will increase rather than diminish the need for meters. It costs more money to furnish filtered than unfiltered water, and the greater the cost the greater should be the economy attending its use.

The Lowell Board of Health spoke very strongly against the extension of the meter system a year ago, from a health standpoint. It seems to fail to realize that it is not the use but the waste of water that meters are designed to obstruct. Indeed, in many communities objections might not be urged even against waste, provided only those who waste pay the cost of the extra pumping, increased size of mains, reservoirs and other accessories which their waste causes.

The fact that the practice of so-called "economy" in railway operation by merely cutting down expenses must eventually result in increased expenditure is not as fully recognized as it should be by many of the higher officials in railway service, it being too frequently assumed that every dollar cut off from requisitions or appropriations is a dollar saved to the company. There are, of course, exceptional cases in which it is absolutely necessary to reduce expense to the lowest possible figure, but this can be better done after a proper consideration of all questions involved than by merely cutting off the supplies, while in many cases this latter rule of thumb practice is followed whenever there is a period of depression, without any attempt to arrive at a greater real economy in operation. The expensive results of such "economy" are clearly shown by Mr. A. B. Moncrieff, M. Am. Soc. C. E., Engineer in Chief of the South Australian Government Railways, in his report for the year ending with June, 1895, as submitted to the Railway Commissioner. During that year trade was in a very depressed condition, and in the report it is stated that every expenditure on maintenance work which could possibly be postponed without danger to the traveling public was held over. By constant watchfulness the track was kept up for the traffic, which now seems to be increasing, but the engineer points out that the postponement of much necessary work will result in eventually increased cost, while if the lines are to be kept open for traffic it will be imperative to relay long lengths at no distant date. Other portions of the property are deteriorating. Buildings and other structures require repairs and painting, which should have been carried out during the year, but for which it was understood the required provision could not even be obtained for the next year. Mr. Pendleton, the Railway Commissioner, in his report to the Commissioner of Public Works, comments on this state of affairs, and points out that while the track, structures and rolling stock have been maintained in a "sufficient state of efficiency to secure safety to the traveling public, it cannot be denied that the expenditure on repairs, painting of woodwork and bridges, and renewal of rolling stock, has been less than is desirable in the truest spirit of economy." The higher railway authorities, and legislators too, need to be educated up to the point of realizing that the best economy in operation is to be secured by a study of economic conditions rather than by simply stopping the supply of funds.

In our issue of July 18, 1895, we called attention to the proposal for the establishment of a Steam Users' Association by Mr. Edward Atkinson, President of the Boston Manufacturers' Mutual Fire Insurance Co., and incidentally remarked upon the amusement with which engineers would read some of the propositions advanced by Mr. Atkinson in his preliminary circular. The association is now fully organized, with sufficient contributions from manufacturers to pay for a somewhat extended investigation into the subject of boiler economy. Prof. Peter Schwamb, of the Massachusetts Institute of Technology, and Mr. R. S. Hale, of Boston, have been placed in charge of the work, and Mr. Hale is about to sail for England to make an investigation of the subject there. The results of a preliminary study by Prof. Schwamb and Mr. Hale of the literature of the subject of the steam value of various fuels are now printed in Circular No. 3 of the association, of which we have received a copy. It is marked, "Advance copy, subject to revision," and "Copyright, Edward Atkinson." It is explained that the report has been copyrighted "partly on account of its preliminary character, partly in order that the information, so far as it is of present use, may be at once made available with due caution."

The introduction to the report, signed by Mr. Atkinson, contributes almost as much to our amusement as did his original circular, and it is well that it is marked "subject to revision." Here is one of its statements, which would be important if it were true, which we do not think it is:

> It may be remarked that gas possessing illuminating power cannot be distributed in small pipes at high pressure and must, therefore, be made use of very near to its source of production, while gas containing greater heating power may be distributed in small pipes at high pressure over long distances.

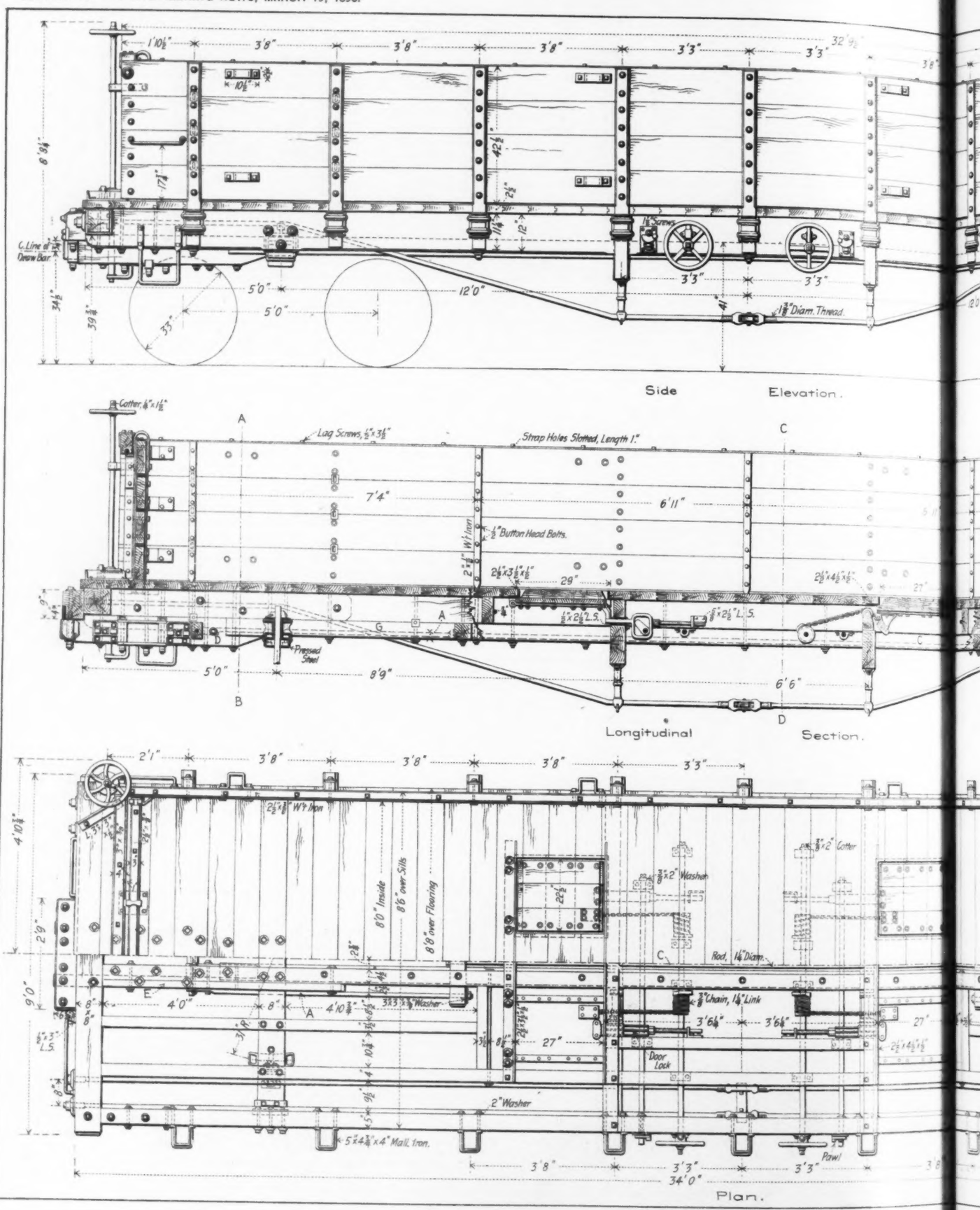
As the heating gas referred to is gas produced from coal, and not natural gas, it would be interesting to know what sort of gas it is which has a higher heating value than illuminating gas. We have hitherto believed that the latter has at least as high a heating value as any other kind of gas that has been produced artificially from coal.

By far the most novel and amusing proposition, however, is one which Mr. Atkinson develops from experiments he has made on ovens for cooking food, in which he found that 2 lbs. of oil or 40 cu. ft. of illuminating gas would do as much work as 100 to 125 lbs. of coal burned in a stove. Reasoning from this, he proposes an improvement in steam boilers, which he describes as follows:

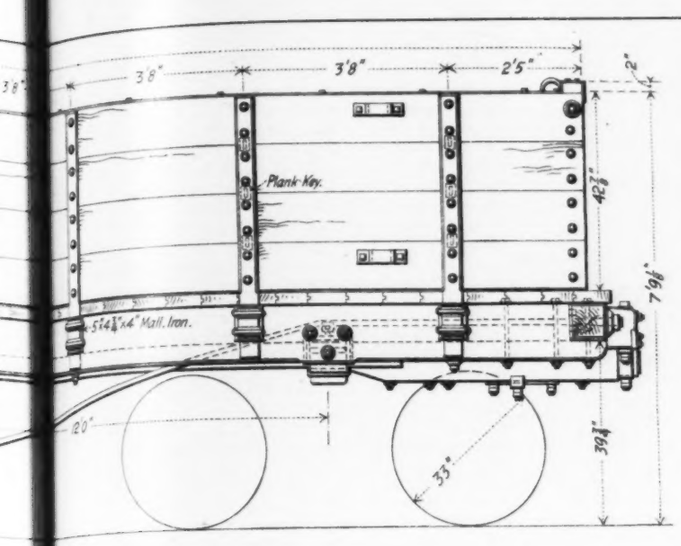
> This has led me to the theory that the true method of developing heat in the production of steam would be to encase a boiler within a non-heat-conducting outer boiler setting, imparting the heat from gas or oil under such conditions that it could not escape through any large draft space or opening, provision being made to promote the small draft necessary for the combustion of the gas through an opening under the boiler from the heat chamber into the combustion chamber immediately under the burners, the necessary supply of oxygen being imparted after the manner of a Bunsen burner.
>
> This is a purely theoretic conception which I now put on record and publish for what it may be worth, so that when this experiment which has proved to be a complete success in a small way in cooking food is applied to cooking water for the purpose of converting it into steam, it may not be impeded by claims for patent rights.

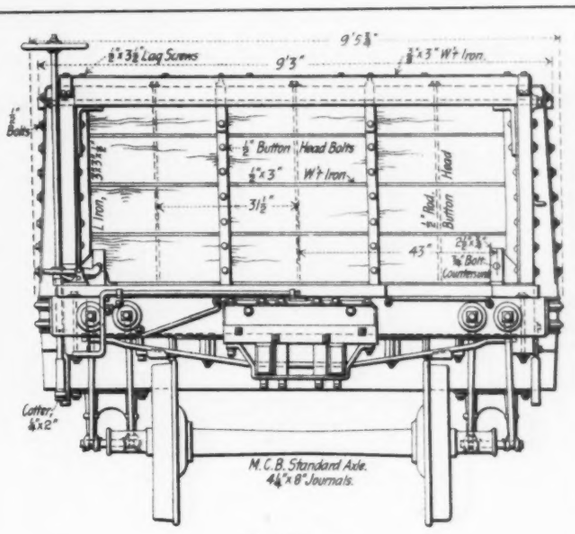
The report of Prof. Schwamb and Mr. Hale on the steam value of various fuels is chiefly a resume of the results of experiments made in 1844 by Prof. W. R. Johnson, in 1860 by Chief Engineer Isherwood and in recent years by Mr. Geo. H. Barrus. The figures obtained from these experiments, together with others furnished by members of the association, are collated and averaged, and the final result shows that the average relative value of the combustible portion of different coals is as follows, George's Creek, Cumberland, being rated at 100: Cumberland, 100; Pennsylvania soft (Clearfield, etc.), 97; Pocahontas, 102; New River, 95; Nova Scotia, 85; English soft (may be higher), 80; Wyoming buckwheat and pea, 97; Lykens Valley, do., 97; Schuylkill, do., 95; Lehigh, do., 92.

Two tables are given in the report, showing respectively the average and the maximum rate of combustion of different coals per square foot of grate per hour, with 1-in. draft, under different boilers. From this we learn that the rate of combustion (when reduced to an equivalent for 1-in. draft) of Cumberland coal under a water tube boiler, in 11 tests, averaged 33.4 lbs., and under a horizontal tubular boiler, in 13 tests, averaged 27.9 lbs., while buckwheat and pea anthracite in 6 tests with the water-tube boiler averaged 22.3 lbs., and in one test with the tubular boiler gave 33.8 lbs. The maximum rates with the tubular boiler for three coals of practically similar nature were: Cumberland, 46.6; Pennsylvania soft, 23.2; Pocahontas, 57.6. These figures are utterly confusing and contradictory, and tend to show the uselessness of attempting to obtain average results from a mass of data of tests made under a great variety of conditions. The only conclusions that we can draw from the figures given in these tables, are, first, that in the several tests from which the figures were taken the rate of combustion of coal per square foot of grate surface per hour with 1-in. draft ranged from something less than 12.3 up to 87.5 lbs., and that the rate depends not only on the character of the coal, but upon the boiler, the grate bars, the thickness of bed of coal on the grate, the accumulation of ashes on the grates, the greater or less tendency of the coal to coke, the method of firing and the personal equation of the fireman.

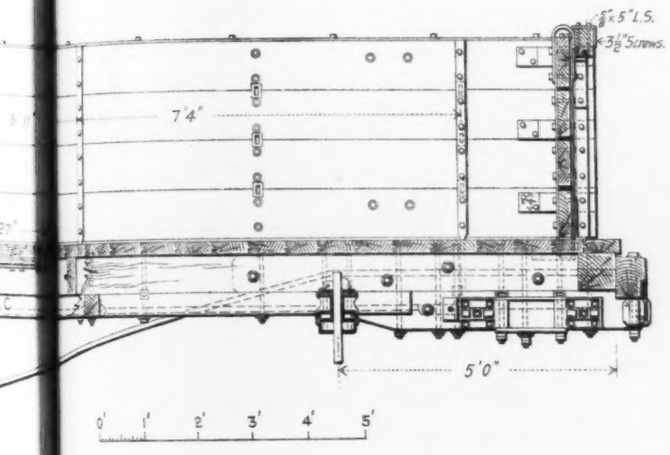

1'10½"
3'8"
3'8"
3'8"
3'3"
3'3"
32'9½"
6'3¼"
10½"
17¼"
42½"
2½"
11¼"
12"
1¼" Screws
C. Line of Draw Bar
5'0"
12'0"
3'3"
3'3"
34½"
39¾"
33"
5'0"
1⅜" Diam. Thread.
Side Elevation.
Cotter, ⅝"×1½"
A
Lag Screws, ½"×3½"
Strap Holes Slotted, Length 1."
C
7'4"
6'11"
½" Button Head Bolts.
2½"×⅜"×1"
29"
2½"×4½"×½"
⅝"×2½" L. S.
Pressed Steel
5'0"
8'9"
6'6"
B
D
Longitudinal Section.
2'1"
3'8"
3'8"
3'8"
3'3"
4'10¾"
2'9"
9'0"
2½"×⅜" W't Iron
8'0" Inside
8'6" over Sills
8'8" over Flooring
⅝"×2" Cotter
⅝"×2" Washer
Rod, 1¼" Diam.
⅝" Chain, 1¼" Link
4'0"
4'10⅜"
3'6¼"
3'6¼"
27"
Door Lock
2"×½" Washer
5"×4¾"×4" Mall. Iron.
Pawl
3'8"
3'3"
3'3"
34'0"
Plan.

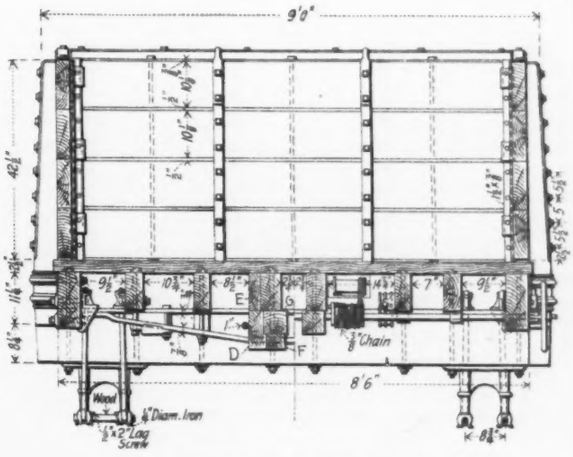
21 MAR 1896



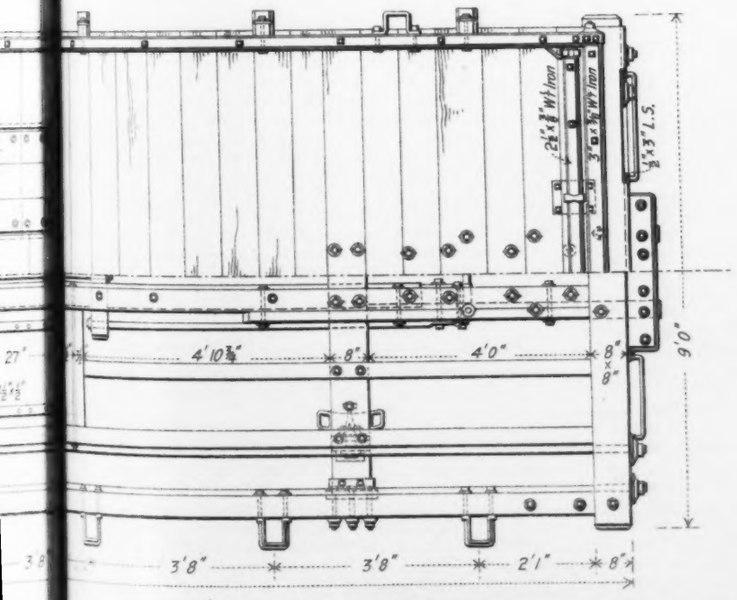


End Elevation.





Half Section A-B. Half Section C-D.



STANDARD GONDOLA CAR

OF 60,000 LBS. CAPACITY.

Lake Shore & Michigan Southern Ry.

A. M. Waitt, General Master Car Builder.

CHAS. HART & SONS, LITH., 88 VESEY ST., N. Y.

We seriously doubt the possibility of obtaining any important conclusions from any study of existing data of boiler tests, other than such as may now be found in such works as Grove's and Thorp's "Chemical Technology," Clark's "Steam Engine" and Barrus on "Boiler Tests." If the research of the Steam Users' Association is going to contribute anything new to our knowledge of fuel and boilers, we believe it will be only such information as it may obtain from an entirely new series of boiler tests, conducted with sole reference to obtaining with them precise information upon particular questions. We trust that the association will soon be prepared to enter upon work of this sort.

The formal adoption of the metric system by the United States has received a considerable impetus by the recent favorable report of the House Committee on Coinage, Weights and Measures, to which the Hurley bill had been referred. The committee is of the opinion, however, that the application of the metric system to Land Office surveys would tend to confusion, and they do not recommend it, for the present at least. In this connection it may be said that the Coast and Geoditic Survey has used the metric system for many years, and has found it eminently desirable in its work and railway engineers now generally modify the old system of land measurements by employing acres and decimals of acres in all right-of-way computations. Aside from the labor and expense of revising the large amount of work already done in connection with the surveys of our public lands, there should be no serious obstacle in the way of the adoption of the metric system, and the change from the meaningless and confusing English units to the decimal units of area would be of great public advantage. The chief point made by the advocates of the Hurley bill is that the adoption of the metric system must be made compulsory, if it is to be adopted at all. The education of public sentiment is necessarily a slow and laborious process, and the only means of immediately bringing about the much-desired uniformity of standards throughout the world is by fixing a date, and compelling the public to take that general interest in the changed standards which they would not do under other circumstances. This the Hurley bill strives to accomplish by providing that the metric system shall alone be used by all the departments of the government from and after July 1, 1898, and that from and after Jan. 1, 1901, this system shall be the only legal system of weights and measures recognized in the United States. The United States, Great Britain, Russia, Denmark and Japan, alone among the civilized nations, have other than metric standards, though, with the exception of Russia and Denmark, the metric system has been legalized in these countries. Its formal adoption by the United States would have a strong influence in leading the others to follow its example; and, in the opinion of prominent Englishmen, if the United States leads off in this direction, England will surely follow. The trade instinct would then overbalance the conservatism that now keeps England out of the metric ranks, by leaving her manufacturers a choice between the American market with English standards and the metric market of the rest of the trading world. No one will deny that there are difficulties in the way of compulsory metric legislation, but Germany overcame these difficulties in two years and Austria in three years, and the general intelligence of the American public should make this task still easier here.

Congressman Stone, chairman of the House Committee on Coinage, Weights and Measures, in his report favoring the adoption of the metric system, shows that almost our entire commerce with the world must now be converted from the terms of our weights and measures into those of the various countries with which we trade. Even in trading with England, our bushel of grain and our gallon of petroleum differ from the English standards; the pound of cotton alone is common to both nations in connection with the articles most extensively sold to England. The nations of the world having an obligatory metric system number over 445,000,000 inhabitants, and these annually import goods to the extent of $344,270,432, and export products to the value of $623,494,498. This population practically includes the civilized world, excepting only Great Britain, Russia and the United States. With Russia, says Mr. Stone, we have no common system of weights and measures to be disarranged by adopting a new system here, and our commerce with that country is small. And we can hardly be said to have a common system with England, for our quart and gallon measure are 17 per cent. less than hers, our bushel 3 per cent. and her 100-weight and ton exceeded by 12 per cent. the corresponding weights most extensively used in this country. We have the same terms, with different values, and the confusion is greater than if the terms were distinct.

The metric system, from its decimal character, is convenient and economical in practical use. We recognize this convenience in our decimal coinage, and it should need no lengthy argument to demonstrate the wisdom of applying the same system to weights and measures. The saving of time alone in the practical operations of everyday life is beyond the possibility of intelligent estimate, says Mr. Stone, and he quotes the estimate of the late English parliamentary committee, that the adoption of the metric system in English schools would save "not less than one year" of school time. Our own educators generally concur in this estimate, and Mr. Stone remarks that the actual result of a persistence in our old methods is the needless waste of 15,000,000 years of human life, as represented by the wasted efforts of the school children of the United States. The House Committee, after "careful consideration" of the subject, unanimously recommended the exclusive use of the metric system in this country after July 1, 1898, for all the departments of the government, and by the whole nation after Jan. 1, 1901.

THE PROPOSED EXPERIMENTS ON THE FILTRATION OF THE PHILADELPHIA WATER SUPPLY.

Philadelphia has an excellent opportunity to place itself in the front rank of American cities in the matter of a pure water supply. A bill is before the common council appropriating $250,000 for "one or more experimental or permanent filter plants." Few cities in the United States are in greater need of a new and pure water supply than Philadelphia. For 20 years the badness of its water has been proverbial. Many a person throughout the country remembers the "Philadelphia fever" contracted by himself or some relative or friend during the Centennial. The Schuylkill water was responsible during that great exhibition for a vast amount of sickness and death, the troubles ranging from light bowel disorders to severe cases of typhoid fever. Since 1876, as before, Philadelphians have suffered with typhoid, and hundreds of deaths have been caused by the disease. The water supply is responsible for a great part of this trouble, and will continue to be so until it is purified or abandoned.

Not only does the water cause disease, but it is often disgusting in its appearance. Until recently the bad appearance was chiefly confined to earthy turbidity, but of late washings from the coal regions have transformed the yellow dirt to black dirt, and the water at times has had a most inky hue.

From time to time purification or a supply from a new source have been discussed, sometimes most vehemently and clamorously. There have not been lacking ardent advocates of each of the plans named, but thus far they have simply checkmated each other. This, to an outsider, seems to have been largely due to the fact that the advocates of purification wanted to put in a political system of filtration, and the supporters of a new source wished to build political water-works. Or, in other words, the great question was, "how much is there in it" for us, the advocates of each plan seeing more "in it" for them than in the other scheme. It is only fair to say that there has not been lacking another element in Philadelphia whose only interest has been pure water. The individual members of this element have favored some the one and some the other general plan, and sometimes have been obliged to work against any plan on account of the corruption involved.

It would seem as though this plan of procedure had been followed long enough. The death roll from typhoid, caused by impure water, has reached a length that calls for a change; the discomforts, and worse, of dirt laden and coal laden water demand a change; decent and business-like government demands a change.

As to what the change should be, whether to purification or a new supply, is a matter of hygiene, engineering and finance. Politics and private greed should hold no sway against health and life and the interests of the public purse. It is well known that an expenditure of several millions of dollars would introduce a new and pure gravity supply. This would render pumping unnecessary, but the great capital charges would largely, if not wholly, offset this, and there are uncertainties as to the rights or needs of other communities with reference to some of the suggested sources. On the other hand, the Schuylkill, and, notably the great Delaware, flow by the very doors of the city. Immense pumping engines stand ready to pump, are now pumping an enormous volume of water to meet the city's needs—and wastes. The water is impure, but science, both by carefully worked-out theory and experiment, and by practice on a large scale, has demonstrated that impure water can be made pure. If the present sources can be continued by means of purification the initial outlay will be vastly less than for a distant gravity supply, and instead of paying out money now to build works ample for years to come, extensions can be made from time to time as the demands increase.

To determine without question the possibilities of filtration under the local conditions existing at Philadelphia it is desired to expend $250,000 in establishing and operating a filter plant. With this sum enough water can be treated to put the work entirely out of the experimental and into the practical category, and, best of all, a considerable quantity of water, vastly improved, if not rendered perfect, can be supplied to a long-suffering community.

Some members of the common council, unable to urge valid arguments against the proposal before them, have resorted to the plan too common among councilmen and other men when hard beset for explanations of a questionable course—of making wholesale denials of either the need or the feasibility of the proposed improvement; they rant against science and misquote or misinterpret scientific authorities. Under these circumstances Mr. John C. Trautwine, Jr., Assoc. Am. Soc. C. E., Chief of the Bureau of Water, has done just what any man in his position may properly do, if not in duty bound to do, he has in plain but gentlemanly language gone over the allegations and arguments of the opponents of filtration and pointed out the errors and misstatements made, at the same time going further and showing what filtration has done elsewhere.

The public press of Philadelphia, with only one exception, so far as we know, realizes its duty to defend the public interests, and urges that there should be no delay in the attempt to secure pure water. It urges the passage of the proposed appropriation, and that investigation should be made with the greatest possible expedition.

The agitation for water purification at Philadelphia and the probable cost of constructing and operating the proper plant or plants for this purpose emphasize the urgent necessity of throttling the criminal waste of water now going on there. If waste, pure and simple, were to be instantly cut off in the Quaker City, further enlargements of the works would be unnecessary for some time to come and the money thus saved would go far towards constructing a purification plant, while the pumping expenses saved might more than pay the yearly cost of purification. It is shameful for Philadelphia to spend such vast sums of money year after year in enlarging its water-works merely in order that waste of water may go on unchecked when its citizens are sickening by thousands and dying by hundreds on account of the sewage-polluted water supply served to them.

LETTERS TO THE EDITOR.

A Low Bid for Engineering Work.

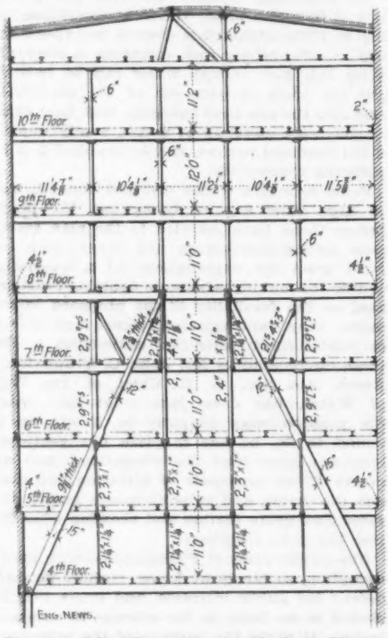
Sir: The city of Sherman, Tex., advertised for bids to make a topographical survey, contour map, complete plans, specifications and estimates of cost of a sewer system; also plans, specifications and estimates of cost of methods of sewage disposal, profiles of all streets, establishing proper grades to insure good drainage, with record book of all items in the above, and permanent burch marks at all street intersections. The city has a population of about 12,000, and covers with outlet connections five square miles. The contract was let to a man who did not even profess to be a rodman, for $375. Several engineers bid on the work, presenting credentials and references, but were ignored because a party underbid them. Evidently education and experience are at a discount here. J. T.

Trusses in Iron Building Construction.

Sir: I note in your issue of March 5 a description of a big truss in the new extension of the Waldorf Hotel, which is described as "a somewhat novel development in structural iron work."

Permit me to call your attention to the trusses which we designed and had erected in the Drexel Building, Philadelphia, in 1887, of which a very complete description was published in the "Engineering and Building Record," May, 1889. On pages 539 and 541 of that paper will be found plates and description of heavy trusses extending up through four stories and carrying respectively seven and eight floors over the Drexel Bank and the Stock Exchange room, the clear spans being 48 ft. 10½ ins. and 53 ft. 3½ ins. I enclose a blue print of these trusses.

The Drexel Bank had been built before in one story about 47 ft. high in the clear without any intention of ever placing an addition above it. The foundation walls had to be underpinned, the foundations widened out



Elevation of East Truss, Carrying the Upper Floors of the Drexel Building; Philadelphia, Pa.

with concrete, and iron pilasters placed against the walls to carry the increased-loading.

In years gone by we had previously employed this same principle in wooden construction for stories over large spans, such as with dining-rooms in hotels, in a number of instances. For the large waiting room in the Reading Terminal Station in this city, we used steel girders 85 ft. span, 5 ft. deep.

Yours very truly,
Joseph M. Wilson,
Wilson Brothers & Co.

Philadelphia, Pa., March 10, 1896.

(The truss illustrated is that on the east side, and has a depth of about 44 ft. extending from the fourth to the eighth floors, with the intermediate floors carried by hangers from the top chord, and by posts outside the truss. The truss on the west side, over the Drexel Bank, is of similar design, but of slightly less span, and extends from the fifth to the ninth floor.—Ed.)

The Proposed Free Wharves for New Orleans.

Sir: In April, 1891, the city of New Orleans leased the wharves along the left bank of the river from Toledano to Piety St. to the Louisiana Construction & Improvement Co., a corporation of this city, with the following officers: President, M. D. Lagan; Vice-President and General Manager, Charles K. Burdeau; Secretary and Treasurer, M. D. Lagan, Jr.

The lease was made for a period of ten years, expiring May 28, 1901, for the following consideration: The lessees agreed to spend the sum of $465,000 during the first two years on improvements and repairs to wharves, and for every year thereafter to pay the city the sum of $40,000 in cash, and in addition to spend $35,000 for building new wharves, making a total sum of $1,065,000. All work performed by the lessees was to be subject to approval of the city engineer and commissioner of public works.

These wharves, the property of the city of New Orleans, cover fully seven-eighths of the total wharfage on the river front. The city council has adopted an ordinance by which the city treasurer is directed to pay the sum of $450,000 to the Louisiana Construction & Improvement Co, for the unexpired term of their lease, say five years. They propose to have a dock commission, with power of imposing a very small tax on vessels when actually using the wharves, so as to secure an income sufficient to maintain the wharves in good order. This will insure comparatively free wharves, the charges now being excessive.

The $450,000 to be paid is somewhat high, especially when one considers the fact that the opening of free wharves, by the railway companies at South Port (above the city), at Chalmette (just below the city) and for about a half mile immediately above Toledano, will make it exceedingly difficult for the present lessees to compete with these free ports and must eventually force them to reduce considerably the present wharfage rates.

Some citizens, to prevent the above purchase, have gone into court and enjoined the city from spending the amount out of the Drainage Fund, on the ground that the money must under the law creating this fund be spent for drainage only, and the matter is now pending.

The term of office of the present city administration ends on April 30 next, and it is very doubtful whether this case can be settled before a new council takes charge. A. Y. Thiard.

New Orleans, La., Feb. 26, 1891.

Finding the Meridian by a Single Solar Observation.

Sir: I enclose herewith a very convenient method of finding the meridian by a single observation on the sun at any hour, the only knowledge required being the declination of the sun and the latitude of the place. As these are the two quantities which must be known in order to use the solar compass or the solar attachment, the method involves no information not used with that instrument. The only observation taken with the method here described is that for the altitude of the sun. The exact time of the observation is immaterial, and this time is not observed. There is nothing new about this method except, perhaps, the method here described by which no special appliances or attachments whatever are required.

The matter given will be added to the next (12th) edition of my work on Surveying, and I send it now to you in order that persons owning previous editions of that work may avail themselves of the description given.

Very truly yours, J. B. Johnson.

St. Louis, Mo., Feb. 20, 1896.

(The matter enclosed by Prof. Johnson is as follows:—Ed.)

Determination of the Meridian by Direct Solar Observation.—Knowing the latitude of the place of observation and the declination of the sun, the angle which a vertical plane through the sun makes with the meridian plane, counting from the North point, may be found by simply observing the sun's altitude. Thus, in the accompanying figure, let Z be the zenith point, P the pole, and S the sun. Then, knowing the latitude of the place, the declination, and the altitude of the sun, the three sides of the spherical triangle ZPS become known, since these sides are respectively the co-latitude, the co-declination, and the co-altitude. Knowing these three sides of the spherical triangle, the solid angle A, or PZS, may be computed from the formula

$$\text{Cos } \tfrac{1}{2} A = \sqrt{\frac{\sin S \sin (S - \text{codec.})}{\sin \text{colat.} \sin \text{coalt.}}}$$

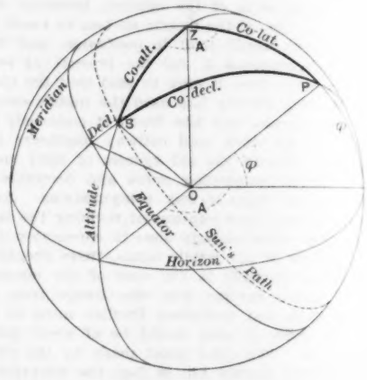
where S is one-half the sum of the three sides.

This kind of a solar observation for azimuth does not necessitate the use of the solar attachment, but it is usually made by means of a colored shield over the object glass, together with a prismatic eye-piece, or in place of these an auxiliary disk or diaphragm, mounted or held just back of the eye-end. This mounted disk may be replaced by a plain sheet of white paper held in the hand some 4 to 6 ins. back of the eye-piece. By having the cross-wires in good focus and the objective focussed on the sun, so as to give a clearly defined image, this image may be brought centrally upon the shadow of the cross-wires by the vertical and horizontal slow-motion screws, within the limits of accuracy of reading the graduated circles. The reading of the vertical circle gives the altitude of the sun, from which the co-altitude is found.

The declination of the sun at the time of the observation is obtained from the nautical almanac, the same as if it were to be used with the solar attachment. Any correction for refraction is also applied. The time of the observation is recorded and the declination of the sun at this time can be afterwards determined.

The horizontal circle is also read, and a pointing made to the azimuth mark, and the horizontal circle read again. These observations can be repeated as often as desired, probably three sets of readings would usually be taken.

The time of day best suited to this observation, like that for an observation with the solar attachment, is near the middle of the sun's path from the horizon to the meridian, either before or after noon. That is to say, the altitude of the sun should be changing rapidly at the



time of the observation. If taken too near the horizon the correction for refraction becomes large and uncertain, and if taken too near noon the altitude is changing too slowly to furnish a good argument.

It needs scarcely to be said that the transit must be in as good adjustment for this kind of direct observation as is required when the solar attachment is used. Also that the mean of two observations taken at symmetrical times before and after noon will eliminate the errors in the instrumental adjustments and also any errors made in the latitude and declination used. This method is now commonly employed in the mining regions of the West, where it is rapidly replacing the use of the solar attachment.

The Calculation of Flat Arches.

Sir: I wish to call attention to an error in the usual method of calculating the stresses in flat arches. To bring out clearly this error, I will compare results obtained by the formula commonly used and results obtained from actual tests. Figs. 1 and 2 show the construction of the arches tested.

The error to which I refer consists in the method used in calculating the pressure due to a horizontal thrust for an equally distributed load, Q.

$$H = \frac{Q\,l}{8\,r},$$

or for a center load, L

$$H = \frac{L\,l}{4\,r},$$

where l is the span and r the rise of the arch.

The thrust thus obtained is divided by the cross-section of the arch at the center, and the result is compared with the known crushing strength of the material, in pounds per square inch. By using this method of calculation a designer will always get a large factor of safety, but a factor which cannot be realized by actual tests if these tests are correctly made. The method is consequently misleading.

The segmental arch shown in Fig. 2 has a 6-ft. span, a width of 4 ft., and a rise of 6 ins. It consists of six tile blocks, with three ¾-in. ribs each. The working section of tile in the center is, therefore, 108 sq. ins. Tests made by the writer show that this tile has a crushing strength of 2,000 lbs. per sq. in. This corresponds to a breaking thrust, according to the formula, of 216,000 lbs. for the arch described. In the actual test made with Mr. Geo. Hill's testing machine the arch broke with a center load of 19,000 lbs., or a corresponding horizontal thrust of 57,000 lbs., which is only one-fourth of the above theoretical figure. To assume that the tile failed under this stress, is just as erroneous as it would be to assume that a masonry column eccentrically loaded failed under a stress obtained by dividing the

load by the sectional area of the column. It would be correct to calculate an arch without a joint, according to Mr. Melan's formula,

$$Ma = Mc - H(y + z),$$

which means that Ma, the moment at any section of the arch, is equal to Mc, the moment of any section of the same structure considered as a supported beam, minus the horizontal thrust times the distance $(y + z)$.

To show that a better approximate theory is possible,

Fig. 1.

Fig. 2.

Figs. 1 and 2.—Showing Forms of Tile Floors Tested by Fr. Von Emperger, New York.

we will consider the arch, Fig. 2, as a column eccentrically loaded with the horizontal thrust. The eccentricity e can be assumed as

$$e = 11 - \frac{I}{A} r,$$

when I is the moment of inertia and A is the section in question. This, at least, is the distance of the line of pressure from the center in the arch theory, and is about in this case 1 in. This figure, substituted in the well-known column formula,*

$$S = \frac{P}{A} \pm \frac{P e}{R}$$

gives, by introducing the figures given above and R the moment of resistance, as 130,

$$S = \frac{57{,}000}{108} \pm \frac{57{,}000}{130} = 1{,}100 \text{ lbs. per sq. in.}$$

This result is far nearer the actual crushing strength of the material, and, consequently, far better to use if any approximate result is to be used at all.

The common method of calculation makes a worse showing if we apply it to the so-called flat arch. Such an arch will generally be calculated in one of two ways: (1) On the assumption that the effective rise is from the bottom flange up to the center of the second rib, which is for Fig. 1 about 5 ins. (2) On the assumption that the effective rise is from the bottom flange to the center of the top web of the arch, which is for Fig. 1 about 8 ins. The section in one case is 108 sq. ins., and in the other case 36 sq. ins. As the failure of this arch occurred under a center load of 10,000 lbs., corresponding to a horizontal thrust either of 38,160 lbs. or 23,850 lbs., the breaking pressure at the time of failure would be either 300 lbs. or 600 lbs. per sq. in. We have the choice of being either one-third or one-seventh of the correct figure. This plainly shows that the pressure limit has nothing whatever to do with the failure, and moreover, that a formula which allows of such a variation is of no use.

The tests now in progress under Mr. Hill's direction should afford an opportunity for getting a correct theory, or at least rules which will enable us to judge the strength of a flat arch by its dimensions.

As for the present method, it cannot be better characterized than by saying that it is an attempt to calculate an arch in the same way that a tie rod would be calculated.

Very truly yours, **Fr. Von Emperger.**

New York, Nov. 8, 1895.

*Eng. News, Nov. 9, 1893.

English and American Dredging Practice.

Sir: I note that one of your correspondents (Eng. News, Feb. 13,) takes up the question of the comparison between British and American dredging practice, and that you invite discussion of the matter. This is a question that is comparable in some respects to the discussion which has been so extensively indulged in with regard to the British and American locomotive practice. Each side has its advantages, and its advocates; but the whole question appears to resolve itself into the general statement that each country employs what is best for its own individual needs, and proves that what will answer the purpose admirably under one set of conditions would not do so under another.

Your correspondent states that in Britain they seem to use the continuous bucket dredge, while here it is never seen. There are, however, many examples of the ladder dredge in this country, and very successful ones; but for the most part they have been designed for special conditions, and are not found along the coast. The writer recalls now about 20 such dredges in different parts of the country, and doubtless there are many more. It is true that in Great Britain the ladder dredge is the prevailing type, but it is not exclusively so. It seems to answer their purpose admirably, and we have records of their work which indicate that it is done, on the whole, at a lower cost per cubic yard than the prevailing prices in this country. The reason for this is to be found not in the superiority of their plant, but in their system of working and lower operating cost.

The whole British system of working is entirely different from the American. There all the large harbor works are in the hands of a Board of Commissioners at each locality, which exercises absolute and independent control of all the harbor and shipping facilities, and also carries on the construction and maintenance. It is thus enabled to construct and own a better plant designed especially for the work and its local conditions and to lay out the work from year to year in the most economical manner, and under the direction of its own engineer, who is always a man especially trained in the local history and requirements of the work. In this way the board is freed from the discouraging irregularity of government appropriations, as well as being free from the incompetency of irresponsible contractors, and the work is executed at cost without profit. Another important factor is the low wages which are paid, as a rule, to the operating crews. I have not the exact figures, but a number of instances have come under my notice in which the wages paid have not been more than 50 to 60% of the corresponding wages in this country. When the foregoing conditions are taken into account it can be readily seen that work can be done at a very low figure, even with comparatively inefficient appliances. The appliances are, however, far from being inefficient, as most of the large Harbor Boards are well equipped with a powerful and complete plant.

Another reason why the endless chain dredge has retained its hold in England is to be found in the character of the work to be done. Almost all of their harbors are exposed to the sea and tidal action, and the greater part of the work consists in deepening the whole areas of the harbors themselves, or the estuaries leading up to them, so that the work is not confined simply to the cleaning out of slips or working in confined spaces, but the dredging of large areas in open channels, and involving the removal of large volumes of material. For work of this kind the ladder dredge is particularly adapted. It is distinctly a seaworthy type of machine, and it is anchored by chains, instead of by spuds, and the buckets while digging are fed over a cut 100 ft. or more in width at one time. Furthermore, they leave a perfectly smooth and level bottom. The prevailing type is known as the hopper dredge; that is, a self-propelling vessel which carries its own load of dredged material. This may seem to some to be an extravagant plant, as the dredging machinery is necessarily idle while going out to sea with its load. On the other hand it must be borne in mind that the crew, and vessel, with its engines and boilers, are not idle during this operation, but are converted into what would otherwise be a scow and tug service, and that on a large and efficient scale. The plant is thus concentrated into one hull and one crew, instead of employing a number of scows and tugs.

For contractors under our system, the heavy investment that would be necessary for a plant of this kind would be a serious objection, and, in fact, they could not consider it at all, for the reason that the outfit of a contractor, to be successful, must be one that can handle all kinds of work. The contractor in this country is liable to have his work divided up in various times, places, quantities and conditions, and he could not afford to run the risk of having a large and expensive machine idle. With the British boards of commissioners, however, the case is entirely different. They have the means at their disposal, and they carefully lay out a plan of action which may take a series of years to complete, each portion of which will be so much to the good, and in which every season's work will be a part of the completed plan. These large hopper dredges are complete ocean-going vessels, with steel hulls, and triple-expansion engines, frequently of as much as 600 to 1,000 HP., and would cost in this country from $80,000 to $150,000 each. There are few works in this country where such machines could be used to advantage, and there are still fewer contractors who could afford to buy them. In some instances the government has procured large and expensive machines for special work, where contractors could not be found to do so, as in the case of the U. S. dredging steamer "Gen. C. B. Comstock," which was built for deepening the bar at Galveston, Texas. A contractor who would own such a machine could only employ it for deepening ocean bars, and it would be useless for any other purpose.

The dipper dredge holds its own in this country as the best all-around machine, of low first cost and simple parts, and which can fulfill all ordinary conditions, and its construction has, with us, obtained a higher development than abroad. The best examples of it are to be found upon the lakes. The absence of tides enables the dredges to be pinned up on the spuds with greater facility, and they can thus do harder and heavier work than when afloat on spuds which are not pinned up. There are dredges of this type on the lakes which have excavated as much as 4,450 cu. yds. of clay in ten hours, from a depth of 20 ft., loaded into scows. They carry a dipper of from 4½ to 6 cu. yds. capacity, and are handled with as much ease as a smaller machine, and with a very much smaller crew than the British machines. Clam-shell or grapple dredges hold their own on the seacoast for soft material, and for their special character of work it will be difficult to find a better machine.

The dredging operations in this country are largely in the hands of local contractors, who, from the nature of their surroundings, have not been able to make the advances which have been made in other lines of machinery. For the most part they are men without engineering training, and their knowledge has been obtained by hard experience and sometimes expensive mistakes. They are thus prone to think that the experience which they have so dearly paid for is extremely valuable, and that the degree of success they have obtained by their own methods could have been obtained in no other way. Besides this, there are continually being added to their numbers, men, who, without any training or experience whatever, enter upon important contracts entirely unprepared, being attracted by the hope of large profits on a government contract. This unfortunate class is continually burning its fingers, in attempting to execute work with appliances which are wholly inadequate and frequently ridiculous, and bring discredit upon themselves and discomfort and disappointment to their employers, and are as well a thorn in the side of the reputable contractor who is really well equipped for his work.

It is hard to find a remedy for this condition of things, without a revolution which is impracticable, and it remains, therefore, for each contractor to find out for himself what the best and most efficient plant is for his own work, and to increase his profits by decreasing the cost at which he is able to do the work. The man who has the broadest experience, and who sees the most of what others are doing in the world, will realize that there are other means of accomplishing the same result than those which he has been employing, and he can often take a leaf out of other people's books with great advantage to himself.

Another fruitful cause of poorly constructed and inefficient dredging machines that are to be seen about the country is found in the fact that the builder of them, instead of going to some established and responsible manufacturer of such machinery, undertakes to compile a machine himself, by buying the boiler of one man, an engine of another, and the additional parts of someone else, and perhaps building the hull himself, and attempting to assemble them together without any well-defined plan before hand. The result is a patch work, and a machine which, from the nature of the case, cannot be well harmonized, and for which he can hold no one responsible but himself. Breakages so frequently occur in dredging machinery that contractors have begun to look upon breakages as an absolute necessity, and to be counted on with reasonable certainty. It is true that the strains and wear and tear on dredging machinery are perhaps more severe than in any other form of mechanical construction; but it is also true that by careful designing and adaptation of each part to the work to be done, as the result of experience, breakages can be so greatly reduced as to be very rare, and if there were half the attention and care bestowed upon dredging machinery that is bestowed upon other branches of engineering, we would not see such clumsy specimens of designing as we frequently do, nor would the users of such machines be troubled with such frequent break-downs.

Yours truly,

A. W. Robinson, M. Am. Soc. C. E.

South Milwaukee, Wis., Feb. 25, 1896.

Ladder and Clamshell Dredges.

Sir: In your issue of Feb. 13 a subscriber asks for information as to why the continuous chain and bucket dredging machine (or ladder dredge, as it is commonly called) is not more used in this country.

In point of fact you gave the fundamental reasons in your editorial comments. When a machine of any kind costs more to build and keep in repair than another one to do the same kind of work, there will be no use for it in this country.

For all dredging in soft material, which constitutes seven-eighths of all dredging on this side of the water, the "clamshell" type of machine is used, for the reason that it is the perfection of direct action and simplicity. Nevertheless, for excavation in compact sand, stiff clay or shale rock, the "ladder" type as improved by Mr. John Kennedy, Engineer of the Montreal Harbor Commission is a very valuable tool. The work done by such machines in the St. Lawrence River improvement, in clay, with boulders and shale in ledges, has not been to my knowledge equalled in economy or any similar work in this country or abroad.

N. H. Hutton,
Engineer of Harbor Board.

Baltimore, Md., March 10.

(There are many cases, however, where the ladder dredge possesses special advantages over the clamshell dredge, and where it can therefore be used with beneficial results if the conditions are such as to warrant the expenditure for the greater first cost of the machine.—Ed.)

RACE TRACK OF THE NATIONAL CYCLE & ATHLETIC CLUB AT MANHATTAN BEACH, L. I.

Popular enthusiasm over bicycling has reached such a point that it appears to be as necessary to make provision for the trial of speed of "scorchers," amateur and professional, as it is in the older sport of horse racing, and a great demand has arisen within the past year or two for race tracks especially designed for bicycle riders.

In the vicinity of New York and Brooklyn there has been heretofore no track which was safe for racing at high speeds around the necessary curves, and the attempts of bicyclists to attain high speeds on ordinary tracks have often resulted in disaster.

FIG. 1.—THE MANHATTAN BEACH BICYCLE RACE TRACK.

Built by the National Cycle & Athletic Club. Chas. M. Jacobs, Consulting Engineer; Paul Seurot, Resident Engineer.

In view of this fact, a number of gentlemen interested in cycling in the spring of 1895 approached Mr. Austin Corbin, president of the Manhattan Beach Hotel & Land Co., in order to induce him to take up the matter and construct a track. The National Cycle & Athletic Club was organized as a result of the conference, and Mr. Charles M. Jacobs, its consulting engineer, was instructed to build a track which should be second to none.

The Manhattan Beach Hotel & Land Co., placed at the disposal of the cycle club as much of its property to the north of the Manhattan Beach Hotel as it might require. These lands were formerly the salt water meadows of Sheepshead Bay, which had some years ago been enclosed and drained. The bottom consists of hard white beach sand beds separated by old meadow bottoms formed by the alternate changes in the coast lines, and this bottom makes an admirable formation on which to build up a track.

The first thought was that the longer the better, and a one mile course was suggested. This was quickly dropped in favor of a half-mile track, which was very seriously considered. Experienced riders, however, were of the opinion that if a track were properly banked on the curves, the best results would be attained on a course one-third mile in length; and this, with the evident difference in cost of construction, decided the engineer to make the length on the measuring line 1,760 ft.

The length of track being decided, there remained for decision the questions of (1) the shape of the track, (2) the amount of banking required, (3) the details of construction; and the experience of Mr. J. J. Hawley, Consulting Engineer of the Pope Mfg. Co., was brought into service in designing the track. Obviously the two desiderata in determining the shape of track are the maximum length of tangents and the easement of the curves. An oval track is invariably used for cycling.

In railway alinement it has long been recognized that a transitioned curve is much easier to ride around than a circular curve starting from the tangent, and this plan has been carried out on the race track. A length of 90.88 ft. on the measuring line, on each side of the center line, has been struck circular with a radius of 134.5 ft. Thence an easement curve has been worked in for 162.38 ft. to the point of tangency. The side tangents are each 373.47 ft. in length. This arrangement of the end curves proves of great benefit to all riders. While an expert rider may be quite at home on a circular track, there is no doubt that the great majority of riders prefer long tangents and gradual curvature.

The total length of the track, 1,760 ft., is measured 18 ins. from the inner edge of the curb line of the track, as shown by the dotted line on the plan. It was very important that the track should not measure less than 1,760 ft., as in that case the Racing Board of the L. A. W. would not have accepted any records made on the track. On completion, and after careful measurements, the length was found to be 1,760.04 ft. The track is 26 ft. 5 ins. wide everywhere, except on the home-stretch, where it widens to 40 ft., making it the widest track in this country.

Next comes the question of banking, which so far seemed to have been the stumbling block of track designers. There has been in this country rather a dislike to high banking for no apparent reason. Still it has been proved that the high banked tracks in England and France gave excellent results and that very high speeds were attained, to say nothing of the 100-mile races run on the Paris Velodrome, whose angle is not less than 42°.

The elevation of the banking for the Manhattan Beach track was carefully calculated for every point of the curves, so as to give a gradual rise and fall between the beginning and the end of each turn. The plan Fig. 2 gives the different angles of banking, and Fig. 3 shows sections of the embankment on the home-stretch, back-stretch and curves. These elevations were figured for a given maximum speed and an assumed weight of man and machine, but the theoretical elevations thus found were objected to for two reasons: Firstly, the personal objection above mentioned; Secondly, on account of slow riders. While a professional or Class B rider will spin around at the rate of a mile in 1 min. 57 sec., more or less, many racers will not be able to do it in less than 2 min. 30 sec., and, as the track was built for the improvement of bicycle riding and racing in general, rather than for the benefit of a few record breakers, it was decided to take from 60% to 65% off the theoretical elevations. This, however, will in no way interfere with fast riding, as pacers and scratchmen, as far as they are able, hug the inner edge of the track, where the elevation is less noticeable.

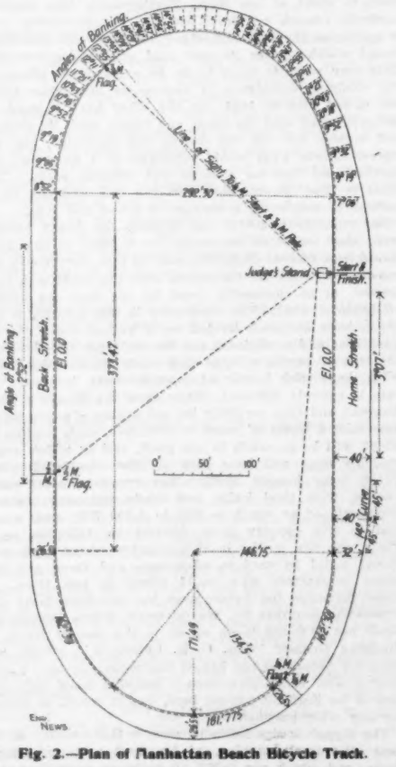


Fig. 2.—Plan of Manhattan Beach Bicycle Track.

The surface of the track was a subject of long discussion. It was necessary to get a surface which would be enduring; resist climatic changes, and, by its composition and its top finish, enable the bicyclist to attain very high speed. It was decided to use artificial stone 4½ ins. thick, made of two layers, the lower one 3 ins. deep, composed of granite concrete (7 parts granite, 1 part sand, 1 Portland cement), the stone varying in sizes from ¼-in. to ½-in. and the top layer 1½ ins. thick, composed of 2 parts powdered granite, 1 part sharp, pure sand and 1 part Portland cement.

This surface would have been rather too smooth, and might have been objectionable in rainy weather as being slippery. Special tools were used to roughen the surface to allow the tires to get a good grip on the track. Experience has shown that very high speeds have been attained even when the track is thoroughly wet.

Such an area of cement (covering 54,030 sq. ft.) had, of course, to be divided into flags to allow for contraction and expansion and prevent cracking. The racing men desired to do away with all flags and interstices between them, as they said that after riding a few miles over them, at the rate of 44 ft. a second, the wheel passing over about seven interstices per second, would communicate such a vibration to the whole machine and rider that the latter would soon be exhausted and out of condition. This, they stated, they had actually experienced on recently constructed ovals where the spaces between each flag measured from ⅛ to ¾ in. Having demonstrated that it was impossible to build a concrete track without providing for expansion and contraction by dividing the surface into flags, small cutting tools of a special pattern were used, making the interstices so narrow and regular that no vibration could be feared, the divisions being like incisions made with the blade of a pen-knife.

To avoid as much as possible the glare of a cement surface in the sun, a proportion of lamp-black was mixed with the concrete for the sake of the riders' eyes. Lastly, black guide lines were painted around the curves; as a man riding at top speed, with his head bent down over his handle-bar, does not notice when he is nearing the curve, and if he does not begin to incline his wheel he will find himself on the top of the bank in the next second. These black lines are placed to warn him that he is leaving the tangent and entering the curved portion of the track.

As shown in the cross section, Fig. 4, the bank is composed of three distinct parts: first, the earth bank; second, an 8-in. layer of ash concrete; third, the 4½-in. artificial stone surface. The earth bank, composed of mixed loam and sand, was deposited by layers of about 9 to 12 ins., tamped down with rammers and rolled by heavy rollers, while streams of water were played on it unceasingly.

Notwithstanding the care exercised in making this earth fill, it was considered unwise to set the artificial stone directly upon it, owing to the fear of local settlement and possible danger of injury due to washouts and frost, and so it was deemed advisable to confine the earth bank in some material impervious to water and frost. Ashes alone were first thought of, but the result would have been little better, and it was then decided to use a concrete composed of ashes, sand and Portland cement. This has given very good results and acquired very considerable strength. To confine or anchor the earth bank and prevent any slipping, the ash concrete was run into the natural ground about 1 ft. below the toes of the embankment. Drainage was another important item for consideration, on account of the location of the track and of the formation of the soil. Test pits were dug and water was found 3 ft. below the surface. There is about 1 ft. of beach sand and beneath it 2 ft. of very dense and compressed, loamy sand, mixed with decomposed vegetation. This makes a very compact stratum which holds water. The north end of the ground was of somewhat lower

elevation, and allowed drainage to be collected at that point. Here a gate was built in the embankment, while a number of 12-in. and 4-in. glazed drain pipes were laid in radial positions to dispose of rain water.

About 9,000 cu. yds. of earth were used in the embankment and 2,100 yds. of ashes in the concrete; 3,275 barrels of American and Belgian Portland cement were used in mixing the ash concrete and in the artificial stone surface.

The construction of the track had been under consideration so long that when at last it was de-

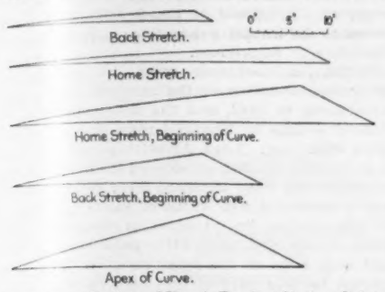


Fig. 3.—Cross Sections of Bicycle Track at Various Points.

cided to proceed with actual work the racing season had nearly begun. Work on the ground was commenced on April 15, and the track was promised to be ready for the meet of the L. A. W., scheduled for June 15. The track was actually finished and turned over to the trainers on June 12, having taken altogether only 51 working days, including wet weather, for its layout and construction. Since all the earth fill had to be borrowed from a distance, this was considered very fast work. There was also included with this track construction the erection of commodious grandstands and bleachers for the accommodation of about 6,000 persons, besides trainers' quarters, approaches, fencing and minor work.

Mr. Jacobs placed Mr. Paul Seurot in the position of Resident Assistant Engineer, while he as-

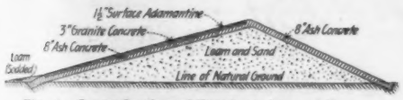


Fig. 4.—Cross-Section of Track at Apex of Curve, Showing Formation of Embankment.

signed various parts of the work of construction to Messrs. J. H. Cummin, J. Cummin, J. E. Denton and W. Cole. The results during the racing season have justified the great care and thought expended on the design and construction of the track, as is evidenced in the fact that there have been more records broken upon it than on any other track in the country in an equal space of time.

It is also very satisfactory to note that now, at the close of the winter, the cement track and embankments are in perfect condition and have shown no evidence of injury due to the severe weather.

STANDARD GONDOLA CAR; LAKE SHORE & MICHIGAN SOUTHERN RY.

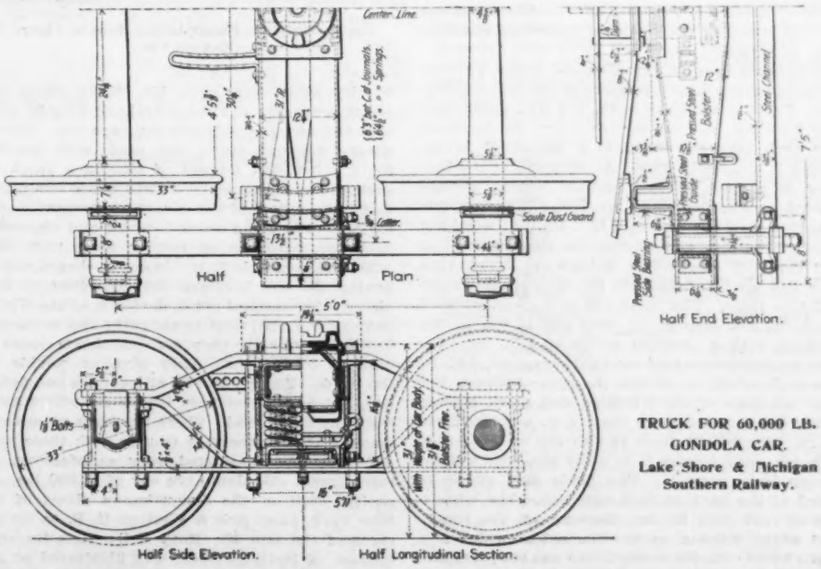
(With inset.)

The new standard 60,000-lb. gondola car of the Lake Shore & Michigan Southern Ry., which we illustrate this week, is intended specially for the heavy coal and ore traffic which this road operates between the lake ports, coal mines and iron works. The reason for using flat-bottom instead of hopper bottom cars is that the cars are for loading steamers, and are emptied by dumping from the end. The car is run on to an inclined table, which tilts up until the floor of the car stands longitudinally at an angle of about 45°, the end of the table projecting over the hatchway in the deck of the steamer. The end gate of the car is then lifted and the entire load of coal shot into the hold of the vessel. This dumping table was described and illustrated in our issue of Sept. 13, 1894. A hopper in the bottom of the car would form a pocket, the coal in which would not be discharged by this method of unloading. It would even be unnecessary to have any doors in the bottom of the car, but for the fact that ore is carried from the lake ports to the furnaces, and there unloaded through the drop doors. The car was designed by Mr. A. M. Waitt, General Master Car Builder, and we are indebted to him for drawings and other information respecting it.

There are six continuous longitudinal sills of yellow pine—namely, two side sills, 5 × 12 ins.; two center sills, 4½ × 8 ins., spaced 5 ins. apart, and two intermediate sills, 4 × 8 ins., these latter being 9½ ins. clear from the side sills. Yellow pine subsills, 5 × 5 ins., are placed below the center sills and bolted to them. Besides these there are two intermediate sills, 3½ × 8 ins., extending from the end sills to the drop door frames and between these frames. The end sills are 8 × 8 ins., of white oak. The car is built with a camber of 1¼ ins. in the frame before the truss rods are screwed up. There are four truss rods, 1⅛ ins. diameter, upset to 1⅜ ins. at the threaded ends for nuts and turnbuckles. They are bent hot to shape, and the bends are 1 in. clear of truss-rod saddles and bearings. The truss depth is 22¾ ins., and the struts are 6 ft. 6 ins. apart, attached to cross-tie timbers or needle beams, 4½ × 12 ins. All the rods pass through the end sills, and the two on each side are 8 ins. apart at the ends and 8¾ ins. at the struts, each strut being formed in one piece for the two rods. A short wooden cross-piece through each pair of open turnbuckles prevents these from turning, the timber being held in place by two lag screws, as shown on the cross-section. The body bolsters are of iron, with the upper member ¾ × 8 ins., and the lower member ⅞ × 8 ins., the truss depth being 5¼ ins. in the clear between the members. The ends of these bolsters rest in iron pockets bolted to the side sills, which pockets also form the saddles for the outer truss rods. The center plates are of pressed steel.

At first sight it would seem as though the draw gear was carried in the old-fashioned way, between short draft timbers bolted underneath the center sills, but on examination it will be seen that the draw gear is made practically continuous from end to end of the car. This is an essential feature of the design, and is introduced in the draft rigging of all the cars on this railway. In the gondola car illustrated there are at each end two 1-in. tie rods, A, attached to the draft timbers, and extending back to the draft-rod cross timber, B, underneath the center sill, just clear of the door openings. A single 1¼-in. rod, C, between the center sills connects the two draft-rod timbers. This arrangement makes the pulling strain continuous, while avoiding the use of a long rod. The subsills, G, are 5 × 5 ins., and extend from the draft timbers to the draft-rod cross timbers, thence to the needle beams, and between these beams, thus making the buffing strains continuous. In box cars, where door openings do not interfere with the design of the framing, an oak subsill, 5 × 5 ins., is placed under each center sill, extending from the draft timbers to the needle beams and between these beams. This arrangement, in addition to tie-rods extending from each draft timber to the needle-beam timber, and from one needle beam to the other, makes the draft rigging continuous for both pulling and buffing strains. As a result, a broken draft rigging is very rare, and Mr. Waitt considers this practice far in advance of that of placing the draft rigging between the center sills, which necessitates lowering the height of the floor of the car about 6 ins. below the ordinary freight platforms. This latter practice, Mr. Waitt states, is being abandoned by some of the roads which first adopted it, including the Chicago, Burlington & Quincy R. R., whose plan was shown in our issue of March 9, 1893. Another arrangement making the buffing but not the pulling strains continuous, is to place a subsill under each center sill, thus forming continuous draft timbers. This is used on the coal cars of the Chicago, Rock Island & Pacific Ry., as described and illustrated in our issue of Aug. 11, 1892.

The draft timbers of this Lake Shore & Michigan Southern Ry. gondola car are 3¾ × 8½ ins., and above each draft timber, D, is a reinforcing timber 2½ × 8 ins. section and 6 ft. 4 ins. long, E, bolted to the outside of the center sill and framed into the end sill. The drawbar stop timbers, F, are of white oak, 4 × 8½ ins., bolted to the center sill and the draft timbers, and extend from the back drawbar stop to the lip of the center plate, the back end of the stop timber being notched out over its full width for a depth of 5 ins. for the subsill G. The drawbar stops are of cast iron, and the draft timber guards of malleable iron. A distance piece, 3 × 5 ins., is framed between the stop timbers, and through it passes a ⅞-in. rod, which ties the stop and draft timbers together. The nuts on the bolts through the drawbar stops are secured by blocks of hard wood. The centre line of the drawbar is 34½ ins. above the rails when the car is empty. The Gould automatic coupler, M. C. B. standard, is



TRUCK FOR 60,000 LB. GONDOLA CAR.
Lake Shore & Michigan Southern Railway.

used, and over each coupler is a white oak dead-wood faced with iron.

The floor is of transverse planks, 2½ × 8 ins., tongued and grooved, and has four doorway openings 27 × 22½ ins. in the clear, the door frames being notched into the intermediate and center sills. The sides of the openings are faced with angle iron. The openings are about 17¼ ins. apart transversely and 7 ft. longitudinally. The doors are made of a double thickness of tongued and grooved planks, and when closed the inside of each door is flush with the floor of

the car. The sides are of planks 3×10 ins., bolted by ½-in. button-head bolts, to stakes of Southern pine 4×5 ins. at the base and 4×3 ins. at the top. There are nine stakes on each side, and these stakes are set in malleable iron stake-pockets 5×4×4¾ ins., secured to the side sills by U bolts. On the inside, opposite the stakes, are wrought-iron straps ½×2 ins. At the two end stakes of each side the planks are also held together by iron keys. The four stakes at the middle of the car are in line with the needle beams, and are extended down against the ends of these beams, thus getting a purchase to prevent bulging of the sides. The upper edge of the side is faced with a wrought-iron strap ⅜× 3 ins. secured by lag screws ½×3½ ins. in slotted holes 1 in. long. The ends are removable. They are formed of planks 3 × 10 ins., separated by wrought-iron straps ½×3 ins., and held together by three vertical ½-in. rods. At one corner of one end of the car is fitted a brake shaft, with malleable iron hand-wheel.

The four doors are operated by two rods or shafts turned by 15-in. hand-wheels, being operated from one side of the car only. Each shaft has two chain barrels, 5 ins. diameter, carrying a ¾-in chain with 1¼-in. links. The chain passes over a sheave on the needle beam, and the end of the chain is fastened adjustably to a bracket on the under side of the door. A spring locking bolt passes under another bracket on the lower side of the door, the two locks for each pair of doors being withdrawn simultaneously by turning the square end of a rod carrying two lugs which work in yokes formed on the locking bolt. Each locking rod is prevented from turning by a pivoted dog on the side of the sill. The doors have each two strap hinges.

It will be noted that malleable iron is extensively used for the fittings of the car, including the door locks, truss-rod struts, stake pockets, draft timber guards, brake wheel, journal boxes, bolster guide bars, washers, etc. These fittings are all made by the National Malleable Castings Co., of Chicago, Ill.

The trucks are of the diamond frame pattern, with the pressed steel bolsters of the Schoen Mfg. Co. The top arch bar is 1¼ × 4 ins., lower arch bar 1×4 ins., and tie-bar ⅝×4 ins. All bends in the arch bars are made to a radius of 4 ins., which is unusually wide. At each end of the bolster is a nest of four double helical springs seated on a spring plank consisting of a Carnegie inverted steel channel, ½ × 12 × 31⅛ ins., weighing 30 lbs. per foot and having the flanges notched for the arch bars. The springs are 7 ins. high free and 6⅝ ins. high with the weight of the car body on them. The bolster is of 7-16-in. pressed steel, 6¼ ins. deep at the ends and 12 ins. at the middle, with a uniform width of 12¾ ins. On this are riveted pressed steel side bearings, 6 11-16 ins. high, of 31 ins. radius, the space between the side bearings of body bolster and truck bolster being ½ in., or not more than ⅝ in. nor less than ⅜ in. The height from rail to top of bolster is 31⅜ ins. with bolster free, or 31 ins. with weight of car body upon it. The Soule dust guard is fitted at the back of each axle box. The wheels are of cast iron, 33 ins. diameter on the tread, and weigh 600 lbs. each. The axles (which are made by the Carnegie Steel Co.) and the journals, boxes, lids and keys are all specified to be strictly in accordance with the M. C. B. standards for 60-000-lb. cars. The cars are fitted with the Westinghouse quick-acting brake, with Christie M. C. B. brakeshoes hung inside the wheels, and carried by the National hollow steel brakebeam. The Peerless Rubber Mfg. Co.'s brake hose is used.

There have been 1,000 of these cars built: 500 by the Michigan Peninsular Car Co., of Detroit, Mich.; 250 by the Union Car Co., of Depew, N. Y., and 200 by the Madison Car Co., of Madison, Ill. The general particulars of the car are given in tabular form below, and may be compared with those of the cars noted in the editorial on large cars in our issue of March 12.

60,000-lb. Gondola Car; L. S. & M. S. Ry.

Length over end sills	34	ft. 0	ins.
Length inside	31	" 5½	"
Width over side sills	8	" 6	"
Width inside	8	" 0	"
Height, rail to top of sill	3	" 11¾	"
Height, rail to top of side	7	" 9⅛	"
Height, inside	3	" 6⅝	"
Wheels, diameter	2	" 9	"
Journals (M. C. B. standard axle)	4¼ × 8		
Wheelbase, truck	5	ft. 0	ins.
Wheelbase, total	29	" 0	"
Distance c. to c. of trucks	24	" 0	"
Weight of body	15,000		lbs.
Weight of two trucks	11,000		"
Weight, total	26,000		"
Carrying capacity	60,000		"
Total weight of loaded car	86,000		"
Live load	69.76%		
Dead load	30.24%		
Approximate cost	$525		

In regard to the cost of these cars it will be of interest to note the comparison with that of other cars which we have described, as in the following table:

Cost of Coal and Ore Cars.

Date.	Car.	Railway.	Capacity.	Weight.	Cost.
1896	Coal, drop bottom.	L. S. & M. S.	60,000	26,000	$525
1895	" double hopper.	Penna. Lines.	70,000	35,000	$550 to $575
1893	" single hopper.	C. B. & Q.	60,000	24,000	$493
1893	Ore, hopper.	D. & I. R.	53,760	24,000	$450
1892	Coal, flat bottom.	C. R. I. & P.	50,000	26,800	$475

In the report of the committee on "Large Cars," of the New York Railroad Club, an abstract of which was given in our issue of March 12, it was stated that the Lake Shore & Michigan Southern Ry., the New York, Pennsylvania & Ohio Ry. and the Pennsylvania Lines West of Pittsburg had added some coal and ore cars of 80,000 lbs. capacity to their equipment. In response to an inquiry as to these cars, Mr. Waitt states that about ten years ago the road built 50 side dump coal and ore cars of 80,000 lbs. capacity. The ordinary diamond truck was used, with journals 3¾ × 7 ins., but instead of placing a truck at each end of the car only, a third truck was placed under the center of the car, the necessary lateral motion when going around curves and crossovers being provided for by having the center plate with a slotted hole in it, oblong in shape, and by having the side bearings run on rollers on long plates. The central truck device is of the Finlay patent. For coal they do not carry any more than 50,000 lbs.; for ore they are sometimes loaded as high as 100,000 lbs. They give no trouble on the track. These cars run all over the company's line, but have never been loaded for points away from the home road. There has been no unusual amount of derailment or trouble with these cars, and they are considered very satisfactory. A three-truck, side-dump ore car of 80,000 lbs. capacity, built at the Susquehanna shops of the New York, Lake Erie & Western R. R. to the designs of the late Mr. Ross Kells, then Superintendent of Motive Power, was illustrated in our issue of April 19, 1890, and is in general very similar to the L. S. & M. S. Ry. car noted above, being also fitted with the Finlay center truck. It was originally intended to carry the Erie R. R. car on two four-wheel trucks, but the design was changed on account of the protest from the engineering department against carrying such heavy wheel loads over the existing track and bridges. Mr. A. E. Mitchell, Superintendent of Motive Power of the Erie R. R., states that there are now 40 of these cars in service, but that no more of this type will be built. The slanting floor for side dumping necessitates a great waste of space, and the present Erie R. R. standard for coal and ore service is a twin-hopper car of 60,000 lbs. capacity. The center trucks gave no trouble.

FITTINGS AND JOINTS FOR HIGH PRESSURE PIPING.

By John Platt, M. Am. Soc. M. E.

The question of fittings for heavy hydraulic pressures and the best form of joint to use is one that has troubled the minds of many engineers, and caused them no end of worry and annoyance. A glance at the development of high pressure hydraulic connections and joints may therefore be of interest.

Hydraulic machinery came into general use after the invention of the accumulator by Lord Armstrong in 1842, and the development of hydraulic details in England may be said to date from that time. Lord Armstrong evidently took this question up and considered it apart from any ideas he may have obtained from steam practice, and worked out new types of joints and flanges. In this country its introduction progressed much more slowly and with little knowledge of what had been done on the other side. In fact, information on this subject for some reason or other has always been difficult to obtain. It appears evident that in all cases, except where English engineers have introduced the Armstrong practice, the steam flange has been taken and simply strengthened enough to stand the higher working pressure, the broad flat joint being retained.

Fig. 1 is an illustration of a pair of flanges of a construction in very general use in this country. It will be seen that a wide flat joint is used, with heavy flanges and enough bolts to pull the joints together and make it tight, the number being entirely out of proportion to the strength necessary for good practice.. In the original drawing the designer first put four bolts, but afterwards increased them to five, evidently not being satisfied that four would pull the joint together properly.

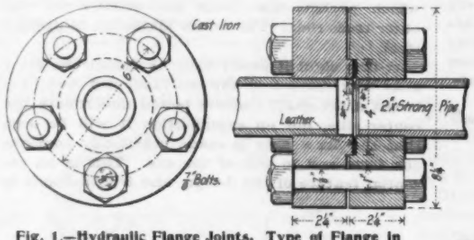


Fig. 1.—Hydraulic Flange Joints. Type of Flange in General Use.

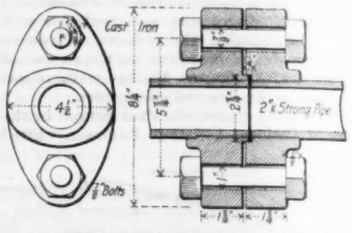


Fig. 2.—Armstrong's Standard Hydraulic Flange Joint.

Fig. 2 shows a standard Armstrong flange for the same size of pipe. This is made up of an oval flange with two bolts (of the same diameter as the five used in the previous case), with a narrow recess for the joint ring, beveled off as shown. The joint is made with a round gutta percha ring, and it is so narrow that it is the easiest possible thing to make a tight joint with the two bolts. In shop practice and the erection of complicated systems of piping, very much less time will be taken by the workmen in making a joint with two bolts than where round flanges and four or more bolts are used. Of course there is a limit to the use of two bolts and an oval flange. For 750 lbs. per sq. in. working pressure this form is used up to a 7-in. pipe. For the 7-in. pipe the diameter of the bolts is 2 ins. For pressures of 3,000 to 5,000 lbs. it will be necessary to use the round flange, retaining the narrow

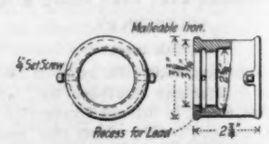


Fig. 3.—"Tight Joint" Pipe Fitting, with Inserted Lead Packing Ring.

joint and four or more bolts, as sufficient strength cannot be so economically obtained by the use of two bolts.

It was usual to make fittings for moderate pressures (say from 750 to 1,500 lbs. per sq. in.) of cast iron, but with the introduction of wrought iron and steel pipe, screwed fittings became general, and this practice was preferred and considered safer. One great trouble that always arose from the use of screwed fittings was the difficulty experienced in making the thread tight in the flanges and fittings, it always being necessary to have it very tight or to screw the ends of the pipe against some material such as copper, lead or leather, to make a joint. Not only was it difficult to make the joints tight, but in piping up a plant with elbows, tees, etc., the lengths had to be exact to get them to come together, and

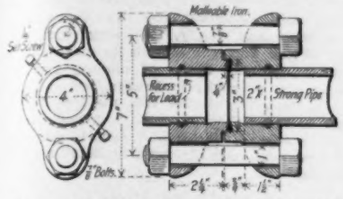


Fig 4.—"Tight Joint" Hydraulic Flange Joint.

often when the piping was complete and the test pressure put on, the first joint made was the one that leaked, and then the whole of the piping had to be taken down again to remake this joint.

Within the last few years a new departure has been made in this country, which makes it possible to use fittings with wrought iron and steel pipe without any of the annoyances mentioned. This is brought about by using what are called "Tight Joint" fittings, made under Folly's patent. A description of these fittings with records of tests made with them by Prof. D. S. Jacobus was given in the Engineering News of Feb. 14, 1895.

Fig. 3 illustrates a 2-in. standard tight joint coupling. The pipe is screwed into the fitting as in the case of ordinary low pressure work, and does not butt against a shoulder. The joint

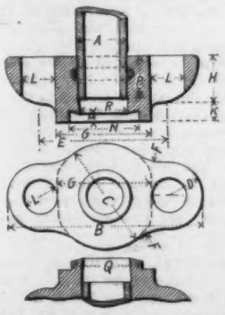


Fig. 5.—Proposed Standard "Tight Joint" Coupling.

is made by means of a lead collar ¼ in. wide by 3-16 in. deep, cast in the fitting three or four threads from the end. Holes leading into the recess are tapped for ¼-in. set screws, one or more set screws being used, according to the size of the fittings. The lead collar is formed on a mandrel of slightly smaller size than the fitting, so that the lead is left projecting a very little beyond the threads. If a pipe is screwed into the fitting, it will expand the lead packing, causing it to tightly fill the screw threads, and if the joint is not made tight by this means, one or more turns of the compressing screw crowds the lead around the pipe and makes it absolutely and permanently tight.

Fig. 4 shows this plan adapted to a two-bolt flange coupling, the joint between the threads being made by the lead, and the flange joint with the gutta percha ring as before explained. These joints are being extensively used for high pressure hydraulic work, and are giving every satisfaction.

The accompanying tables show the sizes of flanges for 750 and 1,500 lbs. per sq. in. working pressure. An effort is being made to have these adopted as standard for these pressures.

In laying suction pipes in shafts and mines, the space is often so confined that it is very difficult to make tight jointas. With the new form of fitting described, all that has to be done when the piping is in place is to tighten up the small set screws with a wrench about 3 ins. long, and a perfectly tight joint can in this way be relied on.

It was at first thought that although this joint would stand well under the test pressure, that it would not withstand the constant hammer produced by the rapid working of hydraulic machines. A long experience in the shops, however, shows that this is not the case, as after extended use there has been no sign of leakage.

A THREE YEARS' COAL RECORD OF A COMPOUND ENGINE.

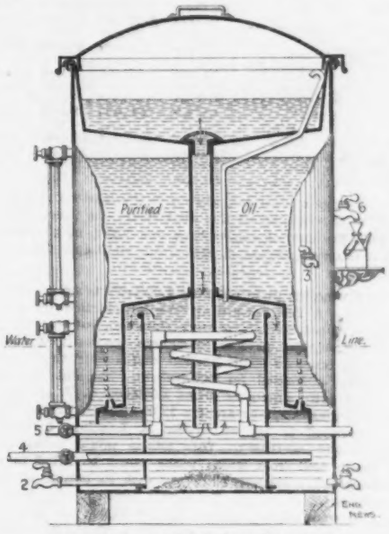
We are favored by the E. P. Allis Co., of Milwaukee, Wis., with the following record of coal consumption for three years of one its compound condensing engines, supplied with steam by two of its Reynolds vertical boilers. The engine was indicated every morning and afternoon, and the average taken for the daily record. The boilers were used exclusively for the engine, and the coal includes that used for all-night banking:

Coal Consumption, Stevens' Linen Works, Webster, Mass. Allis Engine; Cross Compound, 22 ins. and 40 ins. × 48 ins. Two Reynolds Vertical Boilers 84 ins.

	1893.	1894.	1895.
Av. I. HP. for year.....	381	393	396
H. P. hrs. I. HP. for year...	1,042,221	863,792	1,076,134
Eng. coal I. HP. for year, lbs.	1,831,700	1,493,243	1,775,720
Average coal per I. HP. per hour for one year, lbs....	1.76	1.67	1.65

PURIFYING OIL BY WASHING.

We illustrate herewith an ingenious apparatus for purifying oil used for lubrication in machine shops, etc. It is known as the "Perfection Oil Purifier," and is manufactured by the Q & C Co., 702 Western Union Building, Chicago. In the operation of the purifier the oil is caused to slowly trickle through a chamber filled with warm water; the impurities settle to the bottom of the chamber, and the purified oil rises to the top. Referring to the cut, when the purifier is first put into use water is poured into the pan on top until it rises to within 2 ins. of the top of the lower gage glass. Steam is turned on at faucets Nos. 4 and 5 until the water is heated to from 110° to 120° F., and then No. 4 is closed and No. 5 partly closed, so as to maintain about that temperature. Oil is then poured in slowly, not exceeding the rated capacity of the purifier, until it rises to within 2 ins. of the top of the upper



Sectional View of Oil Purifier Made by the Q. & C. Co., Chicago.

gage glass. As pure oil is drawn off from faucet No. 6 an equal quantity of dirty oil is added at the top. Faucet No. 3 is used only when the oil falls below No. 6. Faucets Nos. 1 and 2 are used only for cleaning. In ordinary service cleaning is not required oftener than once in six to twelve months.

WATER FILTRATION AT ALBANY, or a new source of supply, is strongly recommended by the city health board. It is pointed out that in the past twelve years there have been 924 deaths from typhoid fever in Albany, or an average of 77 a year. In no year has the mortality from this disease been less than 50 and in 1895 it reached 162, the highest point. As the population of Albany only increased from 90,575 in 1880 to 94,923 in 1890, it is probably under 100,000 now, but assuming that as the correct figure the typhoid death rate in 1895 was 16 per 10,000, almost equal to the mortality at Chicago in 1891, which attracted world wide attention.

A TEST OF A 15,000,000-GALLON NORDBERG pumping engine at Grand Rapids, Mich., recently, is said to have shown a duty of over 145,000,000 ft.-lbs. on a six days' run. The test was made by Professor M. E. Cooley, of Ann Arbor, Mich.

A BACTERIOLOGICAL LABORATORY for the New Jersey State Board of Health has been provided at Princeton on the University grounds. Mr. Mazyck P. Ravenel, M. D., has been appointed director of the laboratory. Samples of water from public supplies in New Jersey will be examined and a wide range of bacteriological work, as related to disease, will be performed for physicians, and doubtless for local boards of health, free of charge. Dr. Henry Mitchell is Secretary of the State Board of Health, with an office at Trenton.

A SUIT FOR DAMAGES on account of depreciation in the value of property adjacent to a stand-pipe has just been concluded at Sycamore, Ill. In 1887-8 the city built a 15x135-ft. stand-pipe at the crossing of two important streets, the plaintiff's property being a hotel located at one of the corners about 60 ft. from the structure. In the original trial, several years ago, the city secured verdicts in the lower courts, but the decision was reversed by the Supreme Court on the ground that the city had no right to construct the stand-pipe on the public streets. The case was remanded to the lower court to determine whether the exposed stand-pipe is a dangerous structure and to fix the amount of the plaintiff's damages. Expert testimony was given for the city by Messrs. C. B. Davis, W. L. Stebbings and G. E. Horton, of Chicago, and for the plaintiff by Prof. Wm. D. Pence, of the University of Illinois. The re-trial resulted in substantial damages for the plaintiff.

THE COST OF ENGINEERING in thirteen cities of the United States is given by Mr. Almon D. Thompson, City Engineer, Peoria, Ill., in his report to the

Table of Flanges.—Proposed Standard for Hydraulic Piping.

1,500 lbs. Working Pressure per sq. in.

Nominal inside diameter of pipe.	A.	B.	C.	D.	E.	F.	G.	H.	K.	I.	M.	N.	P.	Q.	R.	Size of bolts.	Number of set screw
⅜	.67	3¼	1¾	9-16	2⅛	1	1⅛	⅞	5-16	9-16	3-16	1	13-16	31-32	⅛	½	1
½	.84	3⅝	2¼	11-16	2⅛	1¼	1⅜	1	⅜	11-16	3-16	1¼	⅞	1 7-32	⅜	⅝	1
¾	1.05	4⅛	2⅛	11-16	2⅛	1⅛	2⅛	1 3-16	7-16	¼		1½	1	1 15-32	1	⅝	1
1	1.31	4⅞	2⅜	13-16	3¼	1⅜	2⅜	1¼	½	⅞		¼	1⅛	1 23-32	1 3-16	¾	1
1¼	1.66	5¼	3¼	13-16	3⅜	2	2⅜	1⅜	½	⅞		¼	1⅛	2 3-32	1½	¾	2
1½	1.9	6	3½	15-16	4⅛	2¼	3⅛	1½	½	1		¼	2⅜	2 11-32	1¾	⅞	2
2	2.37	7	4¼	1 1-16	4⅞	2¼	3⅜	1⅝	¾	1⅛		¼	3	2 31-32	2¼	1	2
2½	2.87	7¾	4¾	1 3-16	5⅝	2½	4⅛	2	1	1¼		5-16	3¼	3 7-32	2½	1⅛	2
750 lbs. Working Pressure per sq. in.																	
½	.84	3⅞	2¼	11-16	2½	1¼	1⅝	1	⅜	11-16	3-16	1¼	⅞	1 7-32	⅜	⅝	1
¾	1.05	4⅛	2¼	11-16	2⅝	1¼	2	1	⅜	⅜	3-16	1½	⅞	1 15-32	1	⅝	1
1	1.31	4½	2½	⅝	3	1¼	2¼	1⅛	⅜	⅜	¼	1⅝	:	1 23-32	1 3-16	⅝	1
1¼	1.66	5⅛	2⅞	13-16	3½	1⅜	2⅝	1¼	½	⅞	¼	2¼	1⅛	2 3-32	1½	⅝	2
1½	1.9	5⅝	3¼	13-16	3⅞	1⅜	2⅞	1⅜	½	⅞	¼	2⅝	1¼	2 11-32	1¾	⅝	2
2	2.37	7	4	1	5	2	3⅞	1½	¾	1	¼	3	1½	2 31-32	2¼	⅝	2
3	3.5	8½	5¼	1½	6¼	2½	5	1⅞	¾	1½	5-16	4	1½	3 31-32	3¼	1	4
4	4.5	9⅞	6½	1 5-16	7¼	3	5⅞	2	¾	1⅝	5-16	4⅞	1⅝	4 27-32	4½	1¼	5
5	5.5	11⅝	7⅝	1 9-16	8½	3½	7	2¼	¾	1⅝	⅜	6	2	5 31-32	5¼	1⅝	6
6	6.62	13¼	9	1⅝	10	4½	8	2½	1	1⅝	⅜	7	2¼	6 31-32	6¼	1½	7

City Council of that city for 1895. The figures were obtained direct from the city engineers of the several cities and are for the year 1894. The following are the figures:

Name of City.	Population.	Cost of work.	Total amount.	Cost of Eng'ng P. C. of cost of work.
Burlington, Ia.	25,000	$116,587	$2,300	1.81
Charleston, S. C.	60,000	70,000	3,880	5.54
Columbus, O.	130,000	750,000	20,000	2.66
Duluth, Minn.	50,336	56,228	5,254	9.50
Memphis, Tenn.	75,000	77,451	9,196	11.87
Minneapolis, Minn.	192,358	1,000,000	30,000	3.00
Reading, Pa.	70,000	200,000	6,300	3.18
Saginaw, Mich.	60,000	200,035	8,500	4.25
Salt Lake City, Utah.	50,000	140,000	16,500	11.78
Syracuse, N. Y.	110,000	524,000	15,000	2 86
Toledo, O.	120,000	358,646	17,475	4.87
Kansas City, Mo.	150,000	597,681	25,850	4.32
Troy, N. Y.	68,000	375,000	7,500	2.00

The average cost of engineering in the thirteen cities is 5.24% of the cost of all the work done. In Peoria, Ill., for 1895 the cost of engineering was 1.81% of the total cost of the work designed, staked out and superintended.

A SEA WATER SUPPLY FOR LONDON is again under discussion. A bill permitting the introduction of such a supply passed Parliament some time ago, but was never made use of, the present promoters urging that they found the proposed capitalization and supply too small when they canvassed for subscribers. The old scheme was for a daily supply of about 1,500,000 U. S. gallons, while the present plans are for 12,000,000 U. S. gallons. It is proposed to lay an intake at Lancing, between Brighton and Worthing. This intake would terminate in a pump well from which water would be lifted to a 12,000,000-gallon settling reservoir, with its bottom about 10 ft. below high water. From this reservoir the water would be pumped to another one of 12,000,000 gallons capacity, 500 ft. above the sea, from which it would flow by gravity to still another of the same size at Epsom, 200 ft. above the sea. The intake would be 36 ins. in diameter and the pumping and gravity mains would range, it appears, from 36 to 30 ins. in diameter. The promoters hope to supply some smaller municipalities besides London, and count on a demand for salt water for a great variety of public and private purposes, even boasting that they can furnish it cheaper for street sprinkling than the present local companies can pump it from the Thames. It is stated in this connection that the first English town to use sea water was Ryde, more than 40 years ago; that the next was Tynemouth, in 1872; and that since then it has been introduced in 18 enumerated places, besides some others. All these towns, it is implied, are on the sea coast. The above information is extracted from a paper by Mr. Frank W. Grierson, read before the Society of Arts on Jan. 22, 1896, and published in the London "Architect" for Jan. 31.

THE PURCHASE OF THE UHLMANN BRIDGE charter by the new East River Bridge Commission is declared illegal in some of its provisions by Justice Gaynor, of the Supreme Court, Brooklyn, and he has granted an injunction restraining the commissioners from carrying out their contract with the East River Bridge Co. Justice Gaynor practically holds that the old company, under this contract, not only receives $200,000 for not building a bridge, but it also secures a right of way for an elevated railway across the new bridge, which was the chief purpose of the older bridge company. He denies the exclusive right of the old company to any New York terminus, and it thus has nothing to sell. Commissioner Henry Batterman denies that the old bridge company obtains any exclusive elevated road privileges, as the present commission only agrees to provide tracks for the use of elevated railways, in the line of affording ample facilities for the traveling public of the two cities. But if Mr. Uhlmann's elevated railway happens to be the only one that can readily avail itself of the tracks provided, the gain amounts to about the same thing for Mr. Uhlmann's enterprise.

MASONRY ARCH SPANS of 240 ft. each are proposed for a bridge across the Tennessee River, at Knoxville, Tenn. The Tennessee Legislature has authorized an issue of $225,000 in bonds for a steel bridge; but the citizens of Knoxville have declared for a stone bridge on plans prepared by City Engineer Park. According to the Cincinnati "Enquirer," this stone bridge is to be commenced with the money at hand and the Legislature is to bb asked to make the bond issue $1,000,000. As designed the roadway would be 105 ft. above the river and 50 ft. wide, and the four river arches would have a span of 240 ft. each, with three smaller shore spans. The material would be a pink marble obtained near Knoxville. The arches would be 8 ft. deep at the key and 15 ft. deep at the skewbacks.

CABLE TRANSPORT OF PASSENGERS across the Ohio River, between Cincinnati and Ludlow, Ky., is proposed in a scheme which has been worked out by the Lidgerwood Manufacturing Co. As described by the Cincinnati "Enquirer," two steel towers, each 152 ft. high by 50 ft. square at the base, would be erected about 1,700 ft. apart. Between and over these towers would be stretched four steel carrying cables, running back to anchorages. On these cables would be operated a car weighing 10 tons empty, and capable of carrying 50 passengers. This car would be hoisted vertically within the towers and suspended to the cables by clutches and carriers. A system of towing cables and pulleys would then propel it across the river at a speed of about 1,200 ft. per minute. The estimated cost is $100,000. The permission of the Secretary of War to cross the river with any structure must be obtained before anything further is done.

THE PORT ORCHARD DRY-DOCK, on Puget Sound, Wash., is about completed, and the battleship "Monterey" has been sent there to officially test it. The dock is to be turned over to the government in April.

THE CRUISER "OLYMPIA" is reported as having averaged 20 knots per hour in very rough weather in a late run between two Chinese ports. The officers claim that with smoother water she could easily have made an average of 23 knots, as she made the run mentioned under natural draft, and her headway was so great that the decks were washed by the waves and it was necessary to slow down to avoid damage. The "Minneapolis," which holds a record of 23 knots on her official trial, made this record under forced draft with every condition favorable to speed.

FOUR BATTLESHIPS AND 15 TORPEDO-BOATS are recommended by the House Naval Committee, involving an appropriation of more than $30,000,000. The battleships are to be of not less than 11,000 tons displacement each and will cost, exclusive of armor and armament, not more than $3,375,000 each. The price fixed for the torpedo-boats provides for the finest of their class afloat. The Secretary of the Navy may at once expend any or all of the appropriation for the new war-ships.

THE GENERAL ELECTRIC AND WESTINGHOUSE companies have concluded negotiations resulting in an arrangement with respect to the joint use of certain patents, on terms considered mutually advantageous. After certain exclusions the General Electric Company contributes 62½% and the Westinghouse Electric & Manufacturing Company 37½% in value of the combined patents. Each company can use the patents of the other, except as to matters excluded, each paying a royalty for any use of the combined patents in excess of the value of its contribution to the patents. A board of control manages the patent business, two members being appointed by each company, and a fifth by these four. But each concern maintains its own organization and seeks business for itself. The exclusions referred to consist of foreign patents for cable and underground material.

THE METRIC SYSTEM of weights and measures has been reported upon by the House Committee on Coinage, Weights and Measures, to whom the bill presented to Congress was referred. The committee embodied in its report statements showing the absurdities of and the many and conflicting units now employed in the United States. The conclusion reached by the committee is that the metric system of weights and measures should be adopted by the various departments of the government, although not deeming it wise to change the methods of surveying public lands. They recommend, therefore, that its adoption by the departments be fixed for July 1, 1898, and by the nation at large on Jan. 1, 1901.

A TIDAL CANAL, 4,000 ft. long, by 80 ft. wide and 20 ft. deep, is being excavated at Stockton, Cal. The work is being partially done for the San Francisco & San Joaquin Valley R. R., and is intended to facilitate the loading and unloading of vessels and the transportation of materials for construction required by this railway.

THE MARITIME CANAL CO. of North America is seeking a charter from Congress for the purpose of constructing a ship canal to be not less than 26 ft. deep, and 300 ft. wide, from the Great Lakes to the Atlantic. The bill introduced merely incorporates the company and bestowes upon it nothing in the way of government aid or approval. The capitalization of the company is set at $200,000,000, and its net earnings are not to exceed 5% on this sum. If such an excess is reached the tolls on the canal must be reduced. The company must begin work in three years and complete the canal in ten years. The incorporators are: Luther Mendenhall, G. G. Hartley and T. W. Hugo, of Duluth; Rowland J. Wemyss and L. R. Hurd, of West Superior; Captain F. L. Vance, of Milwaukee; W. B. Dean and P. H. Kelley, of St. Paul; Henry C. Burleigh, of Whitehall, N. Y.; Smith M. Weed, of Plattsburg, N. Y.; James Andrews, of Pittsburg; Luther Allen, of Cleveland; John Birkinbine, of Philadelphia; D. H. Burnham, Lucius G. Fisher and Oscar D. Wetherel, of Chicago; John Bogart, Chauncey N. Dutton, Henry B. Slaven and George S. Stever, of New York city.

ESTIMATES FOR WORK ON NEWTOWN CREEK, N. Y. are to be submitted by the Secretary of War, in accordance with a Senate resolution of March . The purpose is the securing of a channel 18 ft. deep and 125 ft. wide from the mouth of the creek to the head of navigation, in answer to demands from the residents of that part of Brooklyn.

THE BILL LIMITING HEIGHT OF BUILDINGS now before the New York Legislature, is opposed by representatives of real estate men, architects and those engaged in the building materials trade. These men argue that existing regulations impose conditions adequate for security against fire and safety in construction, as far as height is concerned. While the street apparatus of the Fire Department could not successfully handle a fire in the upper stories of very high buildings, it is assumed that independent apparatus can and is used which is sufficient to fight fire; and owing to fireproof systems of construction, the liability of fire is extremely remote. The limiting of the height in proportion to street width is in many cases impracticable owing to the narrowness of the streets. And, finally, the configuration of the lower end of New York city compels the erection of high buildings as the only means of properly transacting business in near proximity to financial and commercial centers. Architects contended that the high buildings could not be objected to on sanitary grounds as they were well ventilated, heated and lighted, and as the upper stories were certainly more healthful than were low buildings.

THE PUMPING OF THE WOLFTONE SILVER MINE, at Leadville, Colo., is about to be stopped, according to press dispatches, and this will greatly inconvenience neighboring mines, whose water has been drained into the lower level of the Wolftone and pumped by the owners of the latter without charge. It is likely that some cooperative arrangement will be effected among the mine owners by which the whole body of ore will be drained and all will share in the expense.

THE PRODUCTION OF PIG IRON has declined, according to the monthly review in the "Iron Age," from a weekly rate of 217,306 gross tons, on Nov. 1, to 189,583 tons on March 1. The stocks on hand at furnaces, excepting those controlled by steel companies, increased from 396,669 tons to 658,790 tons in the same time. The condition of the iron trade is far from satisfactory, for the consumption of iron is now no greater than it was in 1892, notwithstanding the increase in population of the country.

SEWERS FOR CONVEYING SMOKE are proposed as a substitute for chimneys by Mr. W. H. Nichols, of Galveston, Tex. His plan is to concentrate the smoke of factories in large cities, like Chicago and Pittsburg, into a system of underground conduits leading to a large sewer, by which it is to be conveyed to the outskirts of the city. The smoke is to be forced by artificial draft from the furnaces into the laterals leading to the sewer. When it is considered that in order to furnish draft for 5,000 HP. of boilers and remove their gases of combustion there is required a vertical chimney near to the boiler 12 ft. diameter and 200 ft. high, and that the draft is greatly checked by passage through long, horizontal flues, the enormous size of the sewers required by Mr. Nichols's scheme, and its consequent impracticability become apparent.

A UNION TERMINAL STATION on Federal St., at Boston, Mass., is proposed for the use of the Boston & Albany R. R., New York, New Haven & Hartford R. R. (Old Colony Division) and New England R. R., replacing the present three stations on Kneeland St. and Summer St.

A COMBINATION PARLOR, SLEEPING AND DINING car has been built by the American Palace Car Co., of Boston, Mass., for excursion traffic. The main saloon has ten double-berth sections, and there are dressing rooms, lavatories and a kitchen. By day there are individual chairs in the saloon, while at night these are packed between the double floors, and folding frames and partitions are erected to form the berths.

A TRIAL OF A COKE BURNING LOCOMOTIVE was made recently in the Belt Line tunnel of the Baltimore & Ohio R. R., at Baltimore, Md., but after six hours' work the trial was stopped on account of the accumulation of gas, and the normal working with electric locomotives was resumed.

THE TENNESSEE CENTENNIAL EXHIBITION is to be held at Nashville, Tenn., from May 1 to Nov. 1, 1897, and work is now in progress on the buildings, which are to be completed during the present year.

THE INCREASE IN SCALE OF WAGES from 37½ to 45 cts. per hour, asked for by the Bridge and Structural Iron Workers' Union, of Chicago, is being strongly opposed by the contractors, on the ground that the tendency of the times is towards reduced wages and that the state of the trade will not warrant the increase.